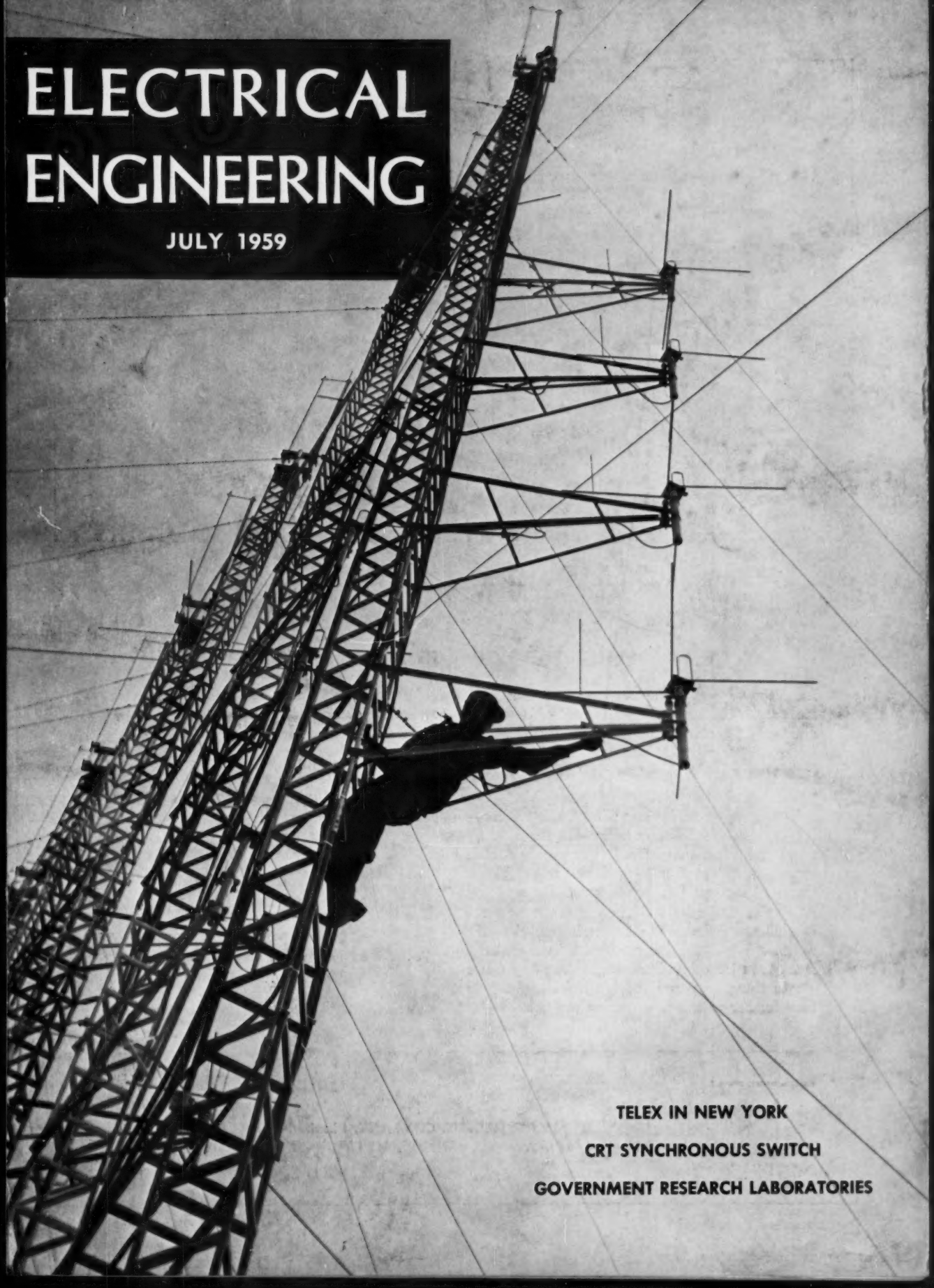
ELECTRICAL ENGINEERING

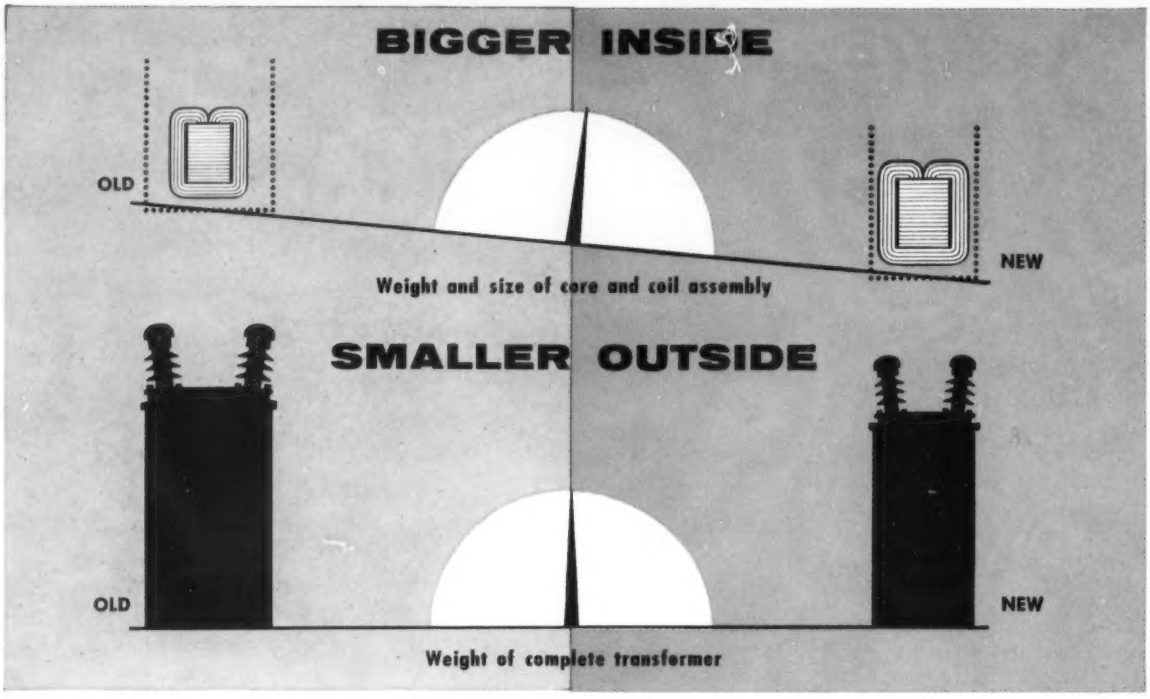
JULY 1959



TELEX IN NEW YORK

CRT SYNCHRONOUS SWITCH

GOVERNMENT RESEARCH LABORATORIES



Here's why you get more for your transformer dollars this year

NEW KUHLMAN DESIGNS ARE *BIGGER* INSIDE, *SMALLER* OUTSIDE

Larger core and coil, using more copper and steel, provide lower losses, improved impedance, and better regulation. A smaller tank takes up less room on the pole and offsets the increased size and weight of the stepped-up core and coil.

With the new Kuhlman '59 Transformer—bigger inside, smaller outside—Kuhlman engineers continue the advances begun with the Kuhlman "Bent Iron" Core. For more than a quarter-century, this has been the most-used principle, industry-wide, to achieve highest transformer efficiency at the lowest possible weight. With the improvement in steel, the Bent Iron Core has done more than any other single thing to make today's lightweight pole transformer possible.

"Bigger inside, smaller outside" is one of the reasons why Kuhlman's 65th year is a big year for you. This year, more than ever, you get more for your transformer dollar from Kuhlman.

Get all the facts from the Kuhlman representative near you.

ALL NEW INSIDE . . .

Conventional above 5KV | Conventional 5KV and below | CSP® | Rural

KUHLMAN ELECTRIC COMPANY 65th year
the year you get more for your transformer dollars

KUHLMAN TRANSFORMERS

KUHLMAN ELECTRIC COMPANY, Birmingham, Mich.

Plants at Bay City, Michigan; Crystal Springs, Mississippi; Salinas, California

ELECTRICAL ENGINEERING

JULY 1959
Vol. 78, No. 7

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75th Anniversary
1884 — 1959
75 Years
A Prologue to the Future

THE COVER: The Site Alpha retransmission antenna tower is 96 feet tall. Soldier of the CDEC Experimentation Troops climbs tower to adjust cable. Installation handles 300 radiophone units over 30 channels. Story appears on page 783.

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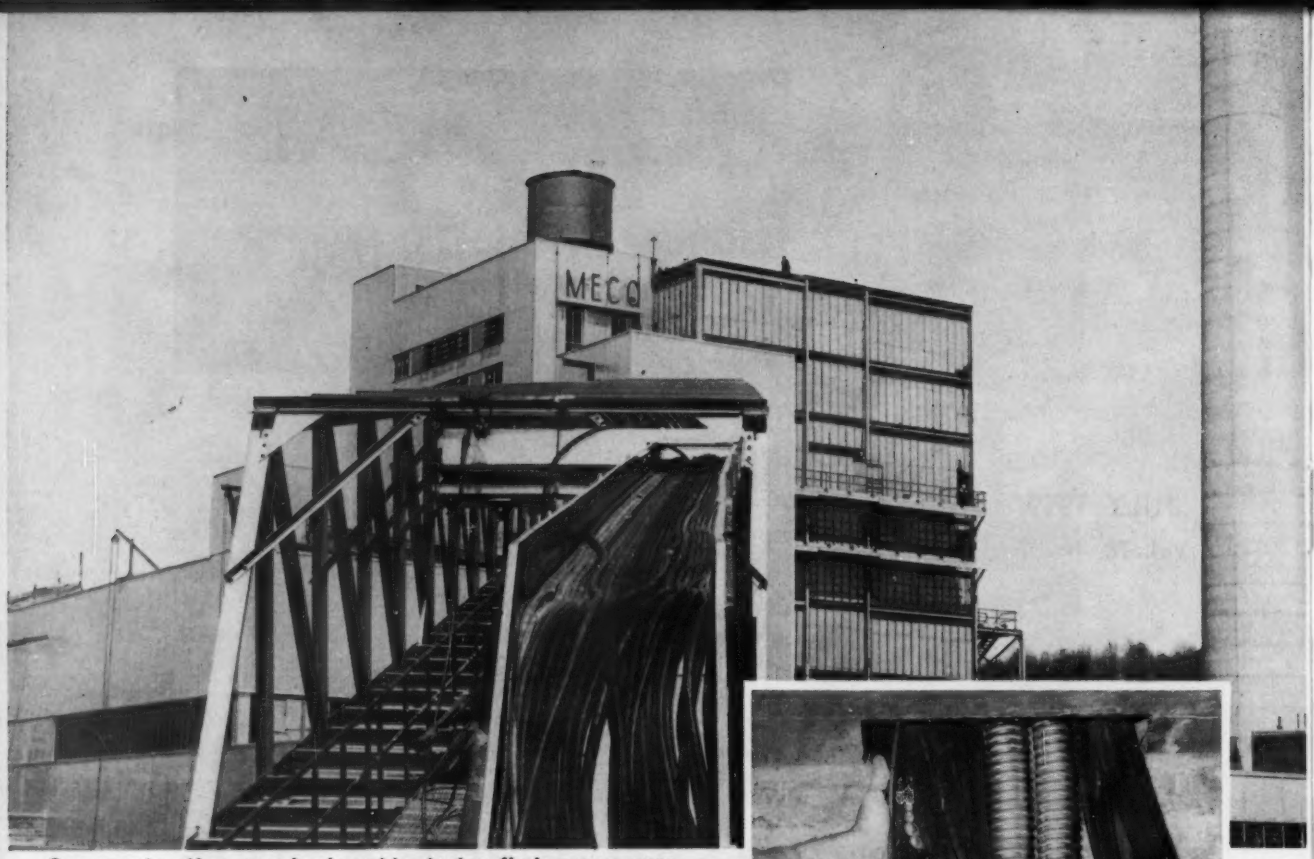

One construction, one basic cable design finds many uses. Open coal conveyor structure shown under construction above carries Okolite-Okoprene power and control cables from Metropolitan Edison Company's new Portland Generating Station to coal storage yard. Three types of the same cable meet in the tunnel (right) beneath the switching station: Okolite-Okoprene with CM-OT finish; Okolite-Okoprene with aluminum Loxarmor; Okolite-Okoprene with straight Okoprene sheath.

Another leading utility picks
Okolite-Okoprene for maximum margin of safety

Utmost reliability, proved by long-term service records, is the reason why Okolite-Okoprene was selected for the brand new Portland, Pa., Generating Station of the Metropolitan Edison Company—engineered by Gilbert Associates, Inc. Various Okolite-Okoprene cables have been installed for 600-volt power and control service with protective coverings designed for specific installation conditions. For example:

- **To avoid expense of conduit...permit quick addition of new circuits**...Okolite-Okoprene power cable with flexible aluminum Loxarmor, in trays, carries power to motors, pumps, coal conveyors, fans and practically all other operating equipment.

- **For maximum protection against soil corrosion, mechanical damage and insect attack**...Okolite-Okoprene control cable with Type CM-OT (corrugated bronze tape) finish is used for direct burial underground circuits to the switching station in the yard. Finish combines remarkable compressive strength with light weight and easy handling.

- **For great weathering strength and resistance to abrasion**... Okolite-Okoprene control cable with an overall Okoprene sheath is used for most other control circuits within station ...and installed in outdoor trays leading to coal storage yard.

Power stations from coast to coast rely on Okolite-Okoprene for vital power and control circuits—a testimonial to its dependability . . . its long life and dielectric strength . . . its resistance to corona cutting, moisture, heat, chemicals and mechanical damage. For further information on this premium quality cable, made by Okonite's exclusive strip-insulating process . . . and its adaptability to your important circuits, write for Bulletin EG-1085, The Okonite Company, Passaic, New Jersey.

where there's electrical power... there's **OKONITE CABLE**

6358

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Charles S. Rich
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Editorial Assistants

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Central Manager and New York

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A. E. Del Gado
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A. O. Dillenbeck, Jr.
West Coast Adv. Office
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Los Angeles 4, Calif.
Tel: DUnkirk 5-3991

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1915 E. Sunrise Blvd.
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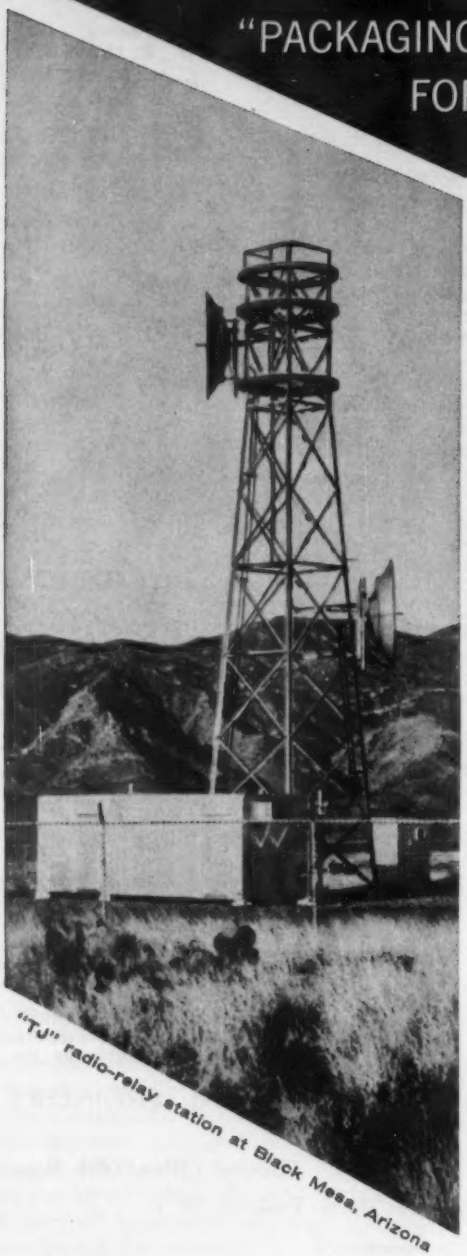

"TJ" radio-relay station at Black Mesa, Arizona

In Arizona, the telephone company faced a problem. How could it supply more telephone service between Phoenix and Flagstaff—through 135 miles of difficult mountain territory?

Radio offered the economical answer: a new microwave radio-relay system recently created at Bell Telephone Laboratories. Operating at 11,000 megacycles, it was just right for the distance, and the number of conversations that had to be carried.

But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in standby equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES *World center of communications research and development*

WHAT BATTERY can match this RECORD?

44 YEARS OF CONTINUOUS SERVICE
WE CERTIFY THAT THIS NIFE BATTERY INSTALLED
MAY 5 1914 PERFORMED CONTINUOUSLY UNTIL 1958
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IT GAVE AND CAN STILL GIVE DEPENDABLE SERVICE
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First Exhibited at the Petroleum Industry Electrical Association Meeting, Galveston, Texas, April 7, 8 and 9, 1959.

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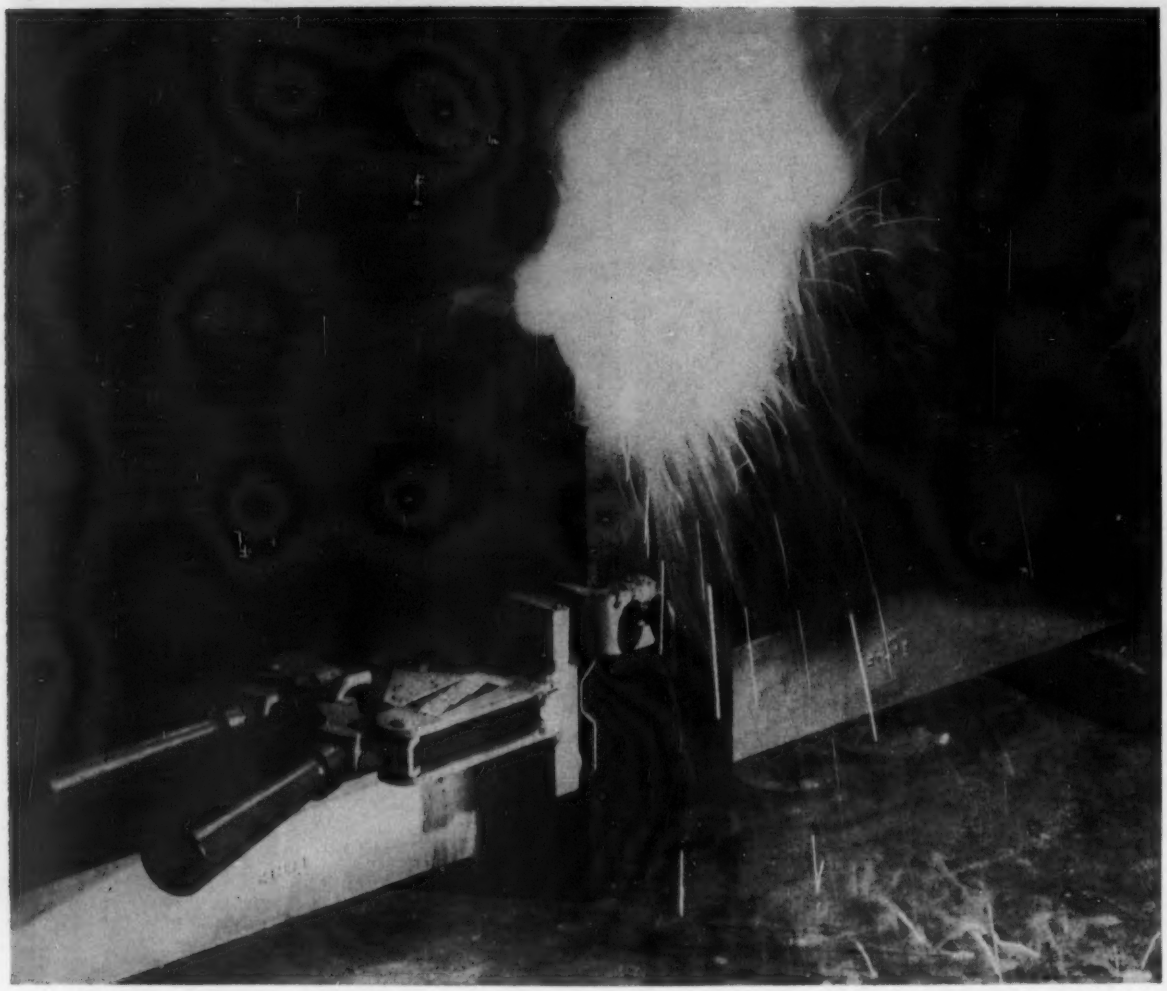

Thermite welding process shown above is used with Alcoa Aluminum in both the utility and industrial fields. Finished welds show electrical conductivity ranging from 97 to 102 per cent of basic conductor. Repeated overload and high-current surge tests indicate no deterioration. Thermite process needs no outside source of heat or power . . . is extremely portable.

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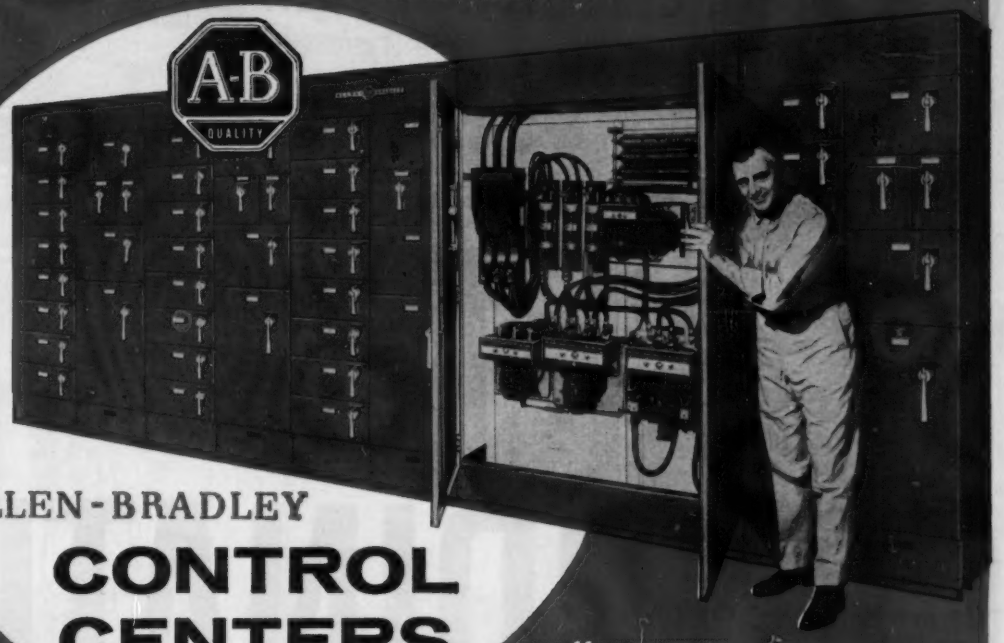

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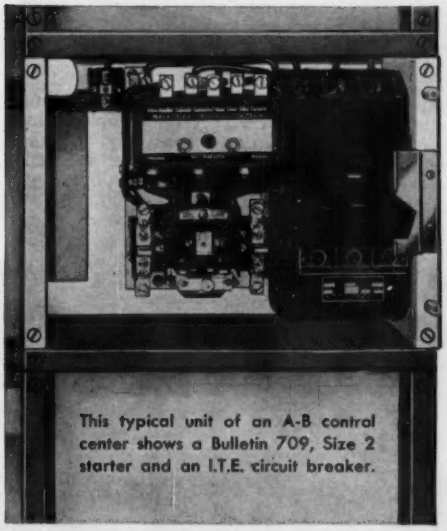
CONTROL CENTERS

. . . offer tops in
FLEXIBILITY · SAFETY
QUALITY APPEARANCE



This typical unit of an A-B control center shows a Bulletin 709, Size 2 starter and an I.T.E. circuit breaker.

Allen-Bradley control centers are the "label" of a modern plant. They make neat, centralized installations and—where this is practical—do away with individual starter mountings and complicated wiring. The control center may even reduce installation cost—as compared with using individual starters. Here are some of the up-to-date design features which make the A-B control centers so popular.

NEW SPACE SAVING DESIGN—New Bulletin 798 control centers save floor space . . . provide up to 8 units in a 90″ high control center unit.

PREMIUM QUALITY FINISH—An exclusive A-B finishing process assures that your control center will retain its attractive appearance over the years. Each piece is *individually* cleaned and phosphated *before* assembly—there are no "bare spots" where corrosion can have a start. Then a rust-resisting primer and a dense finish coat are baked on, providing a fine, tough, and lasting surface.

FLEXIBILITY—A-B control centers are readily adaptable to changes in operating needs—integral plug-in units can be added or modified without internal rewiring. Entire sections are easily added as needed.

SUPERIOR PERFORMANCE—Using the popular A-B solenoid starter—with only ONE moving part—assures millions of trouble free operations. Their double break, silver alloy contacts *never* need servicing.

For "tops" in control centers, you owe it to yourself to investigate Allen-Bradley's Bulletin 798. Write for complete information.

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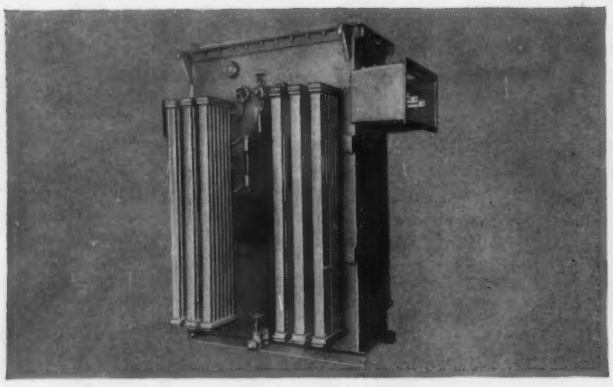
I-T-E CIRCUIT BREAKER COMPANY

COORDINATED

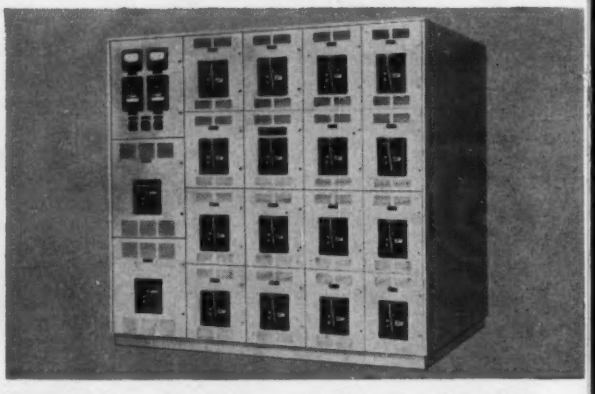
Only I-T-E designs and builds complete primary unit substations in one plant. And because engineers can work so closely together, you benefit from extra time-and-money saving features: better-coordinated designs, easier assembly, pretested performance, and delivery to match your own construction schedule.

At no extra cost to you, I-T-E can custom design and build substations to meet your own particular requirements. In every case you get the additional advantages of I-T-E switchgear . . . sturdier, safer and easier to operate. And I-T-E high-stress transformers incorporate extra protection from fault damage. I-T-E substations are available in all kva ratings and secondary voltages up to 13.8 kv., for indoor or outdoor installation.

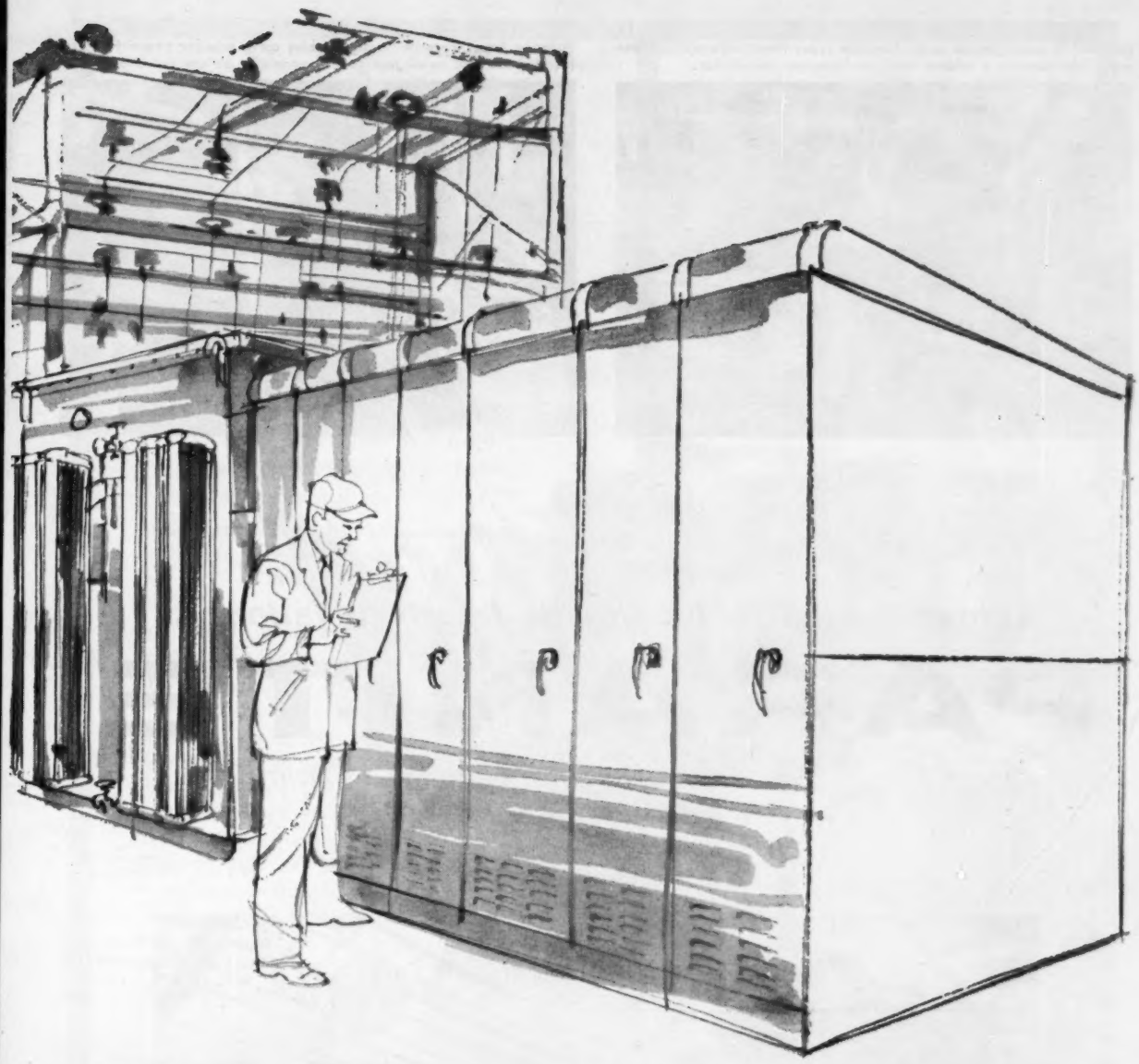
Today more and more electric utility companies are looking to I-T-E as their single source of supply for complete unit substations. For in I-T-E substations, too, they find the advanced design and quality construction to which they are accustomed in I-T-E electrical equipment. Equally important, I-T-E costs no more.

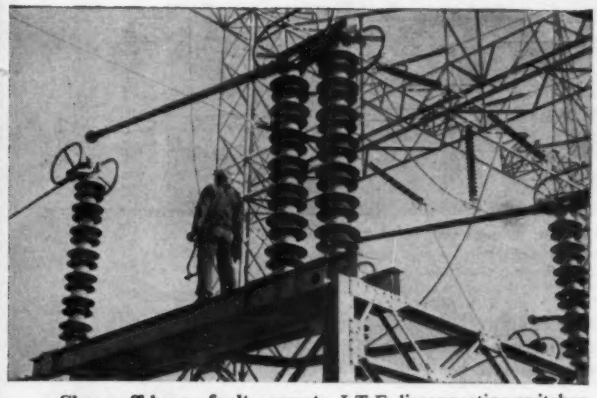


New designs, stronger construction. I-T-E substation transformers are available liquid-immersed or with ventilated dry type or sealed dry type construction. Ratings: liquid—112½ to 10,000 kva, up to 69 kv; dry ventilated—112½ to 3000 kva, up to 13.8 kv; dry sealed—300 to 3000 kva, up to 13.8 kv.



Manual quick-make means greater safety, extended contact life for I-T-E K-Line low-voltage switchgear. Expanded overcurrent trip provides maximum load flexibility. For added safety and convenience, K-Line circuit breakers can be moved to the test position or be disconnected with door closed.





Shrug off heavy fault currents. I-T-E disconnecting switches use heavy silver-to-copper jaw contacts with high thermal capacities to withstand heavy fault currents. Operate easily under severe icing. Available in vertical or horizontal break or tilting insulator configurations.

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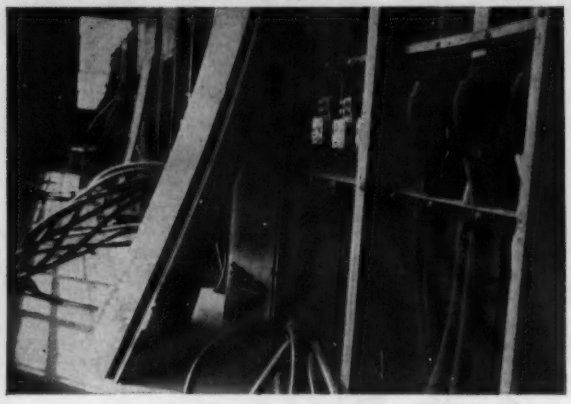
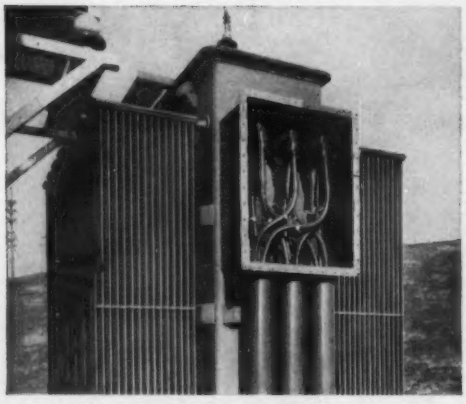
Paranite Super Pararite-Parasyn cables carry primary power between transformers and switchgear control panels in an ore reduction plant.



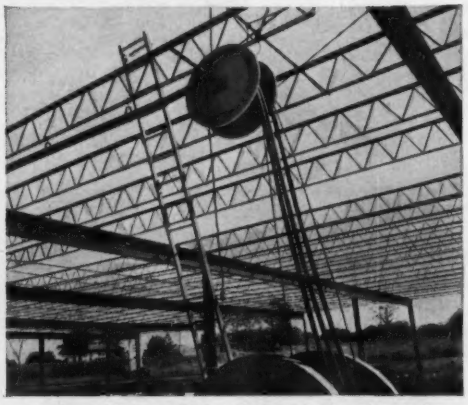
Across the nation for trouble-free installations...

PARANITE®

"IF IT'S PARANITE IT'S RIGHT"®



Paranite Super Pararite-Paraprene cable serves as the primary transformer feeder in a new municipal water pumping station.



Overhead duct installation of Paranite Super Pararite-Parasyn® (PVC) serves as a secondary feeder cable in a manufacturing plant.

The consistent selection and performance of Paranite cables from 600 volt network through 23,000 volt power cables mark them as products of close quality control. These Super Pararite-Paraprene and Super Pararite-Parasyn (PVC) cables illustrated above, indicate the versatility, national availability and proven trouble-free performance of Paranite installations.

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An outstanding feature of the Mears fused breaker is its unique ability to perform with the identical characteristics of a standard air circuit breaker when proper selection of fuses is made.

Available in fixed, semi-drawout and drawout mountings, with or without enclosures, these compact units stack four high. Only 22½" high, 24" wide. Simplified construction assures easy maintenance.

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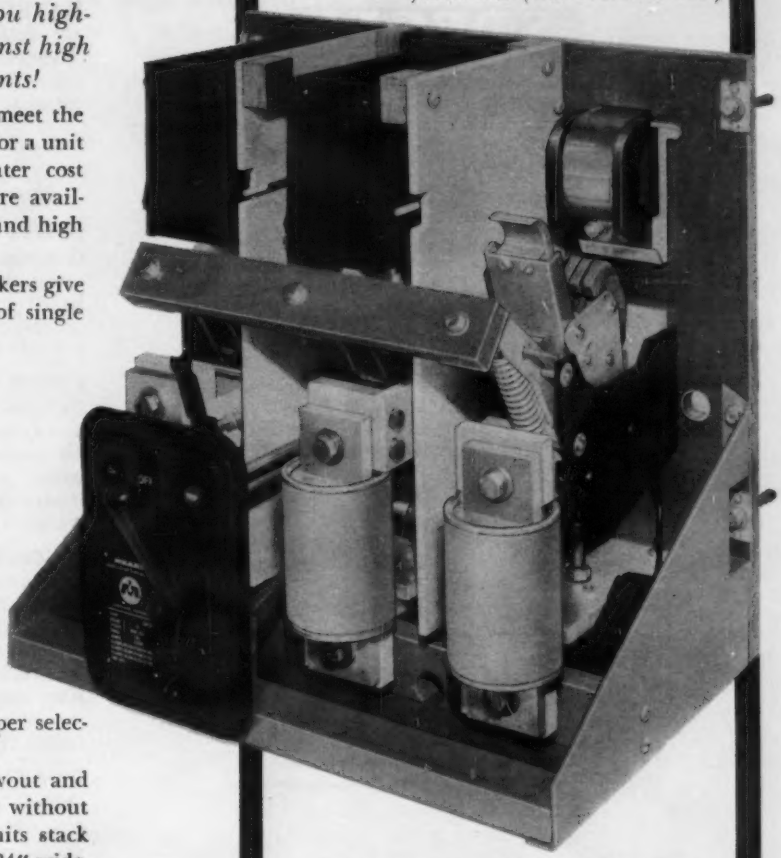

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Mears Electric Circuit Breakers, Inc.
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Gentlemen: Please send me a copy of your Mears Low Voltage Circuit Breakers" Catalog.

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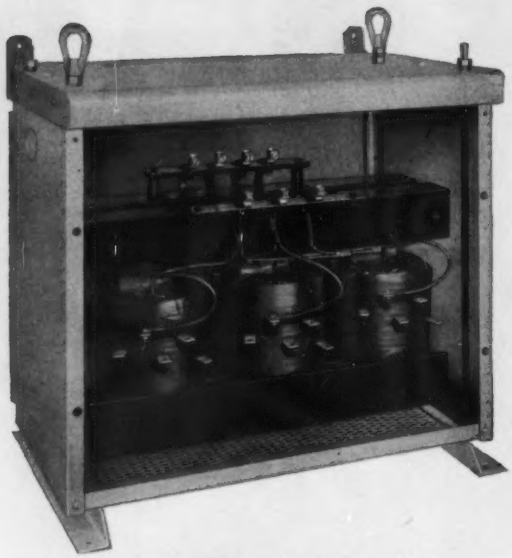
SOUND-RATED DRY-TYPE
TRANSFORMERS



45 Kva 3-phase transformer with taps. Interchangeable wall or floor mounting. Front panel removed, showing interior.

●

COMPLETE LINE FOR EVERY PURPOSE up to 10,000 Kva, up to 15,000 volts, including special transformers and saturable reactors.

The same quiet SORGEL transformers are also incorporated in substations. Procurable with any type or make of switchgear, or from any electrical manufacturer.

The first cost of dry-type transformers is not always the final cost. Don't be misled; the lure of lower prices often camouflages operating and installation costs. SORGEL SOUND-RATED DRY-TYPE TRANSFORMERS are designed and constructed for long life. They provide the absolute ultimate in operating efficiency, ease of installation, overload capacity and long-range economy.

SORGEL offers these proven advantages

LOWER COPPER LOSS — Coils are liberally designed for the most effective use of the latest developments in insulating materials, have large air ducts for low hot spot temperature and are vacuum-impregnated to provide a co-ordinated insulation system.

LOWER CORE LOSS — Cores are designed with the industry's lowest magnetic flux densities, resulting in low core loss and the lowest sound level. The entire unit is secured within a substantial frame. Large units are mounted on vibration dampers to minimize vibration transmission to adjacent areas.

QUICKER AND EASIER INSTALLATION — The enclosure is self-supporting and entrance can be made on sides, top, bottom or back. Connecting is made easier by means of solderless connectors on terminal blocks in roomy connection compartments. Units up to 75 Kva single phase and 45 Kva 3-phase, are furnished for interchangeable wall or floor mounting.

Over 43 years experience in the development, manufacturing and application of transformers, has made these achievements possible.

You will be doing your company or customer a great service when you select the best dry-type transformer made only by . . .

Sorgel Electric Company

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Sales engineers in principal cities.

Consult the classified section of your telephone directory or communicate with our factory.

QUALITY

CADWELD ground rod and cable to steel electrical connections are superior to all mechanical or soldered types.

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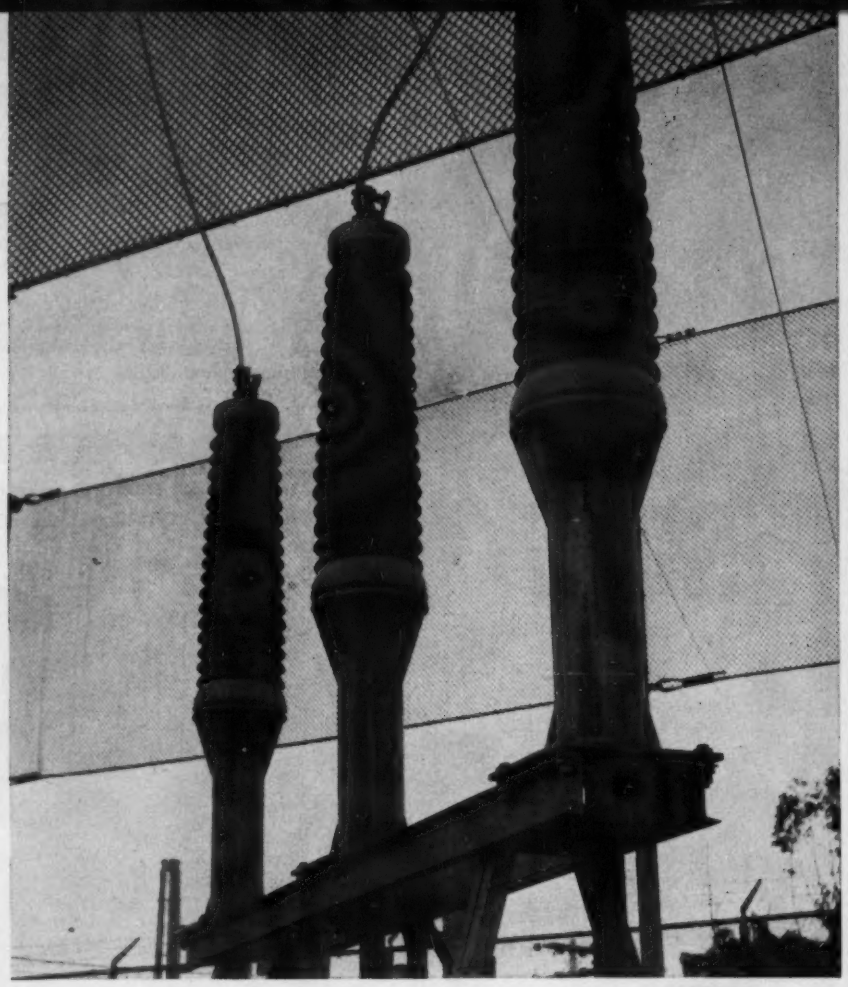
"a significant step forward in the termination of high-voltage cable"*



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The very first pothead to be used commercially was designed by the founders of G&W. Over fifty-five years later and many other "firsts," G&W engineers have produced the most complete line of potheads available to industry. You can specify the pothead of your choice with utmost confidence.

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* *This quote is from an authoritative article titled, "More Power Downtown". The article gives full facts on new ideas used in the construction of a 110 kv underground system on the West Coast. Describes techniques you'll want to know about—"must" reading. Send for your copy today.*

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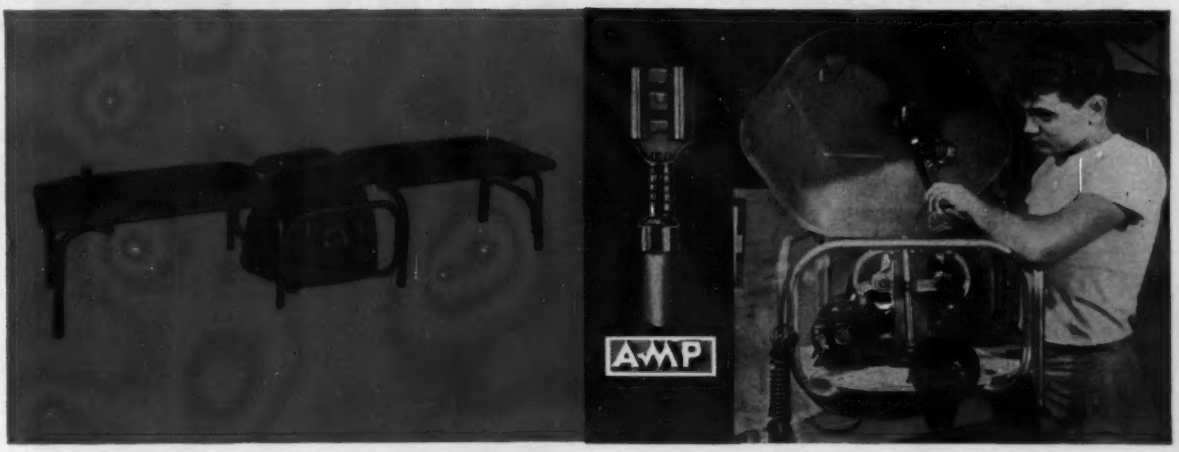
PROBLEM:

Engineers at the Bobrich Products Corporation, Beacon, New York (manufacturers of automatic electric blankets and the Golden Touch Massage Lounge) were trying to make reliable circuit connections the hard way. They raised the cover turret (illustration, below) on their massage lounge a few inches then poked a hot iron through the narrow opening to solder the leads. Trouble was it took too long, it was hard to see and they were never sure that a reliable, permanent connection had been made.

SOLUTION:

The firm eliminated its problem very neatly with the A-MP Faston Receptacle. Bobrich now terminates all leads solderlessly **before** they're installed. Production rates have skyrocketed to thousands per hour with the A-MP Automachine—and, when the turret is fitted over the motor unit, it needs to be lifted only a few inches to permit quick manual insertion of the A-MP Faston Receptacles onto the waiting tabs.



RESULT:

Bobrich got a tremendous boost in production, saved expensive time and now has assured, uniform reliability with each Faston.

You, too, can have all these advantages by using A-MP Faston Receptacles in your circuits. For the full story, including technical data, send for our Faston Catalog.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Japan

An IMPORTANT ADVANCE in DC Power...

Standard 25, 50, 100, 200 and 300 KW—Heavy Duty GERMANIUM and SILICON RECTIFIERS

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- 94%-96% Efficiency • Lower cost per KW • Negligible Maintenance
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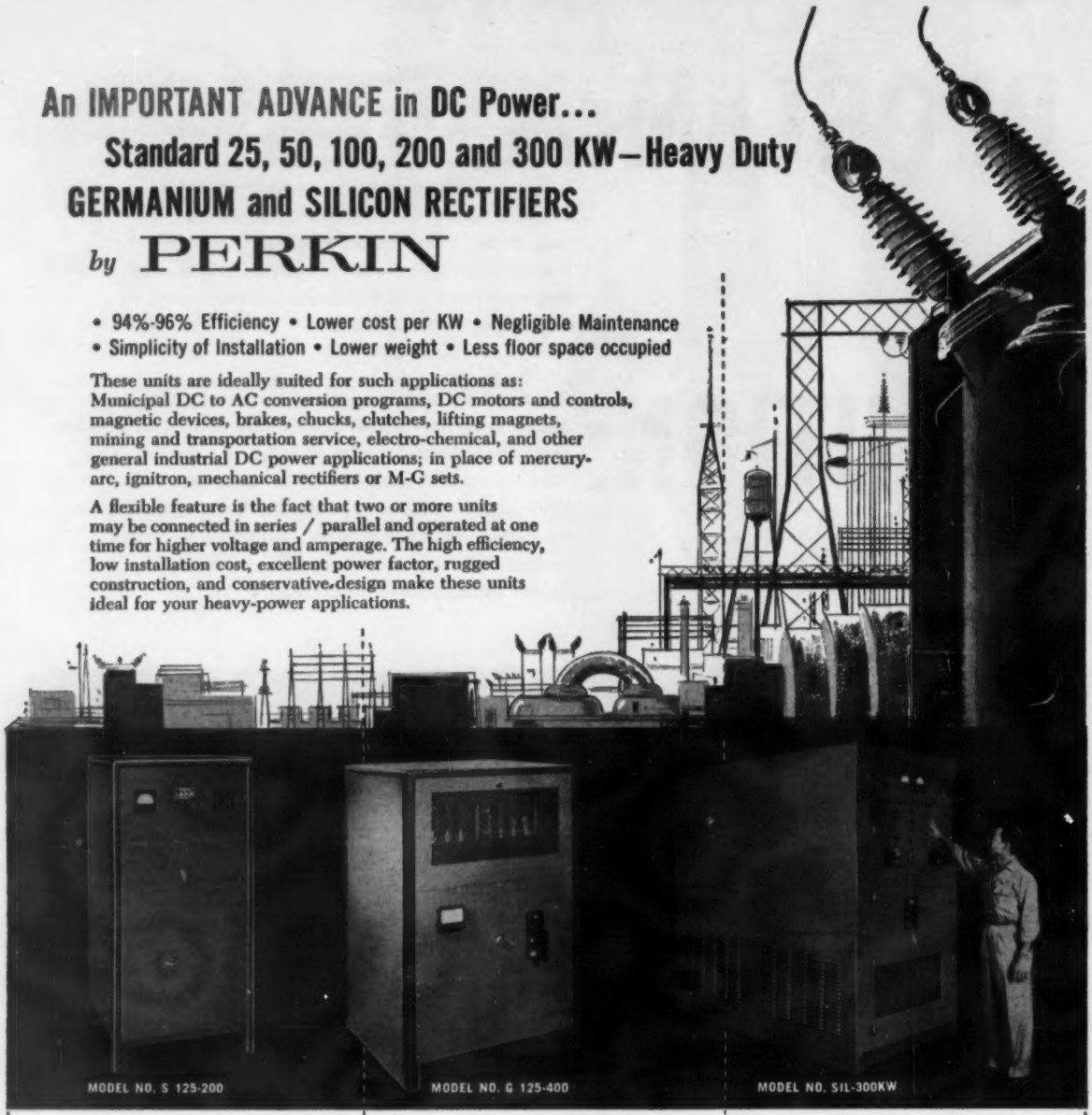
These units are ideally suited for such applications as: Municipal DC to AC conversion programs, DC motors and controls, magnetic devices, brakes, chucks, clutches, lifting magnets, mining and transportation service, electro-chemical, and other general industrial DC power applications; in place of mercury-arc, ignitron, mechanical rectifiers or M-G sets.

A flexible feature is the fact that two or more units may be connected in series / parallel and operated at one time for higher voltage and amperage. The high efficiency, low installation cost, excellent power factor, rugged construction, and conservative design make these units ideal for your heavy-power applications.



MODEL NO. S 125-200 | MODEL NO. G 125-400 | MODEL NO. SIL-300KW

25 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 200/100 amperes
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps (per customer specification)
Voltage Regulation: 5% max.; no load to full load
Ripple: 5% RMS max.
Efficiency: 94%
Duty Cycle: Continuous operation at full load, with ambient temperature of 45°C.

50 KW GERMANIUM RECTIFIER UNIT

DC Output: 115-125 volts @ 400 amps available also connected for 62.5 V @ 800 amperes.
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps
Voltage Regulation: 5%; no load to full load
Ripple: 5% RMS
Efficiency: 94%
Duty Cycle: Continuous

300 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 1200 amps.
AC Input: 460 volts, 3 phase, 60 cps, (2400 or 4160 V also available—please specify.)
Voltage Regulation: 5%; no load to full load
Ripple: 2% RMS
Efficiency: 94%
Duty Cycle: Continuous

100 and 200 KW units, similar in specifications to those above, are also available.

When you require DC power, contact Perkin for a wider range of standard models with prompt delivery schedules. There are over 15,000 Perkin rectifiers in operation in industry today

Contact factory for further data and prices on above units, or send your specifications for prompt recommendations and quotations.

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Official photograph, U. S. Navy

A Salute to the American Institute of Electrical Engineers

The Navy has long been proud of its close association with the American engineering community, a fruitful alliance which has resulted in a sustained record of outstanding achievements.

Electrical engineers can be justly proud of their contributions to the effectiveness and improved efficiency of United States Naval forces. The technical standards of United States Naval ships and associated weapons systems have received world-wide recognition. The progress of electrical engineering over the past 50 years, as reflected in naval ship installations, has been a record of outstanding initiative, hard work, and ingenuity on the part of many technicians who have visualized the potentialities of electricity in shipboard applications. They have worked diligently to translate sound ideas into hard reality.

The widespread use of electric power has entailed a major growth in shipboard electrical installations. With this increasing use of electric power, advanced design concepts have continually been applied to obtain improvement in reliability and effectiveness of the electrical installation and to achieve major reductions in size and weight. Electric equipment designs have been made available for the most rigorous performance requirements encountered in naval service, including extreme conditions of shock, vibration, moisture, and temperature.

Many electric control features have been incorporated which either supplement or entirely replace the human-mechanical function. To increase human efficiency in the shipboard man-machine systems, electrical engineering has contributed improved illumination, air conditioning, and electric-powered auxiliaries such as cooking, refrigeration, laundry, and recreational facilities.

Many ships have been equipped with electric propulsion plants of high reliability, notably the installations on submarines. The advent of nuclear propulsion plants still requires major efforts and contributions on the part of electrical engineers to maintain the desired high level of ship performance.

The resulting "power-packed" and self-sufficient modern Navy ships with widely diversified operating capabilities are in part a tribute to the ingenuity and accomplishments of the electrical engineer. Today the U. S. Navy is deployed in many parts of the world acting as a deterrent to aggression and ready for instant action in support of American policies abroad. The high degree of efficiency in which the Navy can carry out these functions reflects a combat readiness aided by technical achievements undreamed-of 50 years ago.

Admiral Arleigh Burke

Chief of Naval Operations
United States Navy

75 Years—
A Prologue to the Future

The Institute and Its Operations

II. Activities and Services

L. F. HICKERNELL
PRESIDENT AIEE

In this second of three articles, President Hickernell groups all the internal affairs of the Institute into 10 general categories, and briefly describes each one.

THE BASIC REASON for the existence of any society is that it enables members to do together things they cannot do at all, or as well, by themselves. An organization such as ours which attracts 54,000 members has, naturally, a wide range of activity. Reasons for joining are varied. Most members are concerned with the technical aspects; some join to keep abreast of developments through publications; some like socializing on a professional level; others seek the advancement of the engineering profession. It is not essential that all members take part in every activity. It is, however, very important for each member to recognize and utilize the opportunities for collective effort to which he is entitled by virtue of his membership in the Institute.

The operations and activities of the Institute may be grouped into these broad categories:

Membership
Finances
Sections
Student Branches
Technical Activities
Institute Meetings
Publications
Professional Development
Professional Recognition
Headquarters Services

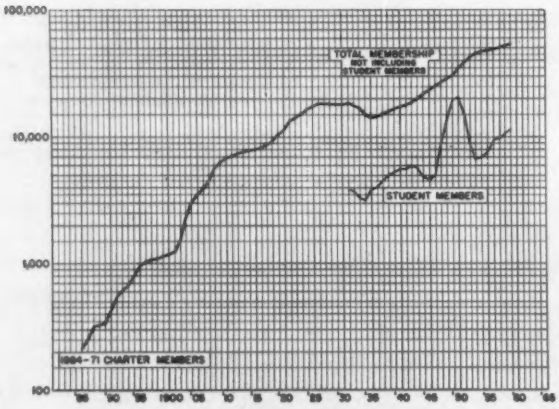


Fig. 3. Total AIEE Membership as of May 1.

AIEE also engages in co-operative effort with other societies on matters of mutual interest. These will be discussed in Part III of this series.

MEMBERSHIP

Fig. 3 shows our yearly membership from 1884 with 71 charter members, to 1959 with our present total of nearly 54,000; and student membership since 1931. Only during the depression of the early 1930's did our numbers decrease, to pick up again rapidly after 1935. AIEE's total growth rate since 1900 has been 5% per year.

Grades of membership were initiated:

Year	*Grade*
1884	Honorary Member
	Member
	Associate
1913	Fellow
1952	Associate Member (formerly Associate)
	Affiliate

Membership grade distribution, as of May 1, 1959, was:

Grade	*Number*	*Per Cent of Total*
Honorary Member	7	0
Fellow	1,572	3
Member	14,342	27
Associate Member	36,140	67
Affiliate	1,766	3

Geographical distribution[8] as of June 1, 1958, was:

Area	*Number*
North America	50,408
South America	329
Africa	93
Asia	613
Oceania	129
Europe	743

Largest overseas membership is Great Britain, 406; then India, 345.

Full text of address presented in abstract at the South East (No. 4) and South Central (No. 13) District Meeting, Atlanta, Ga., April 8-10, 1959; East Central (No. 11) District Meeting, Akron, Ohio, April 22-24, 1959; Empire (No. 1) District Meeting, Syracuse, N.Y., April 29–May 1, 1959; and Middle Eastern (No. 2) District Meeting, Baltimore, Md., May 19-21, 1959.

L. F. Hickernell is vice-president–engineering at Anaconda Wire & Cable Company, Hastings on Hudson, N.Y.

FINANCES

Fig. 4 shows income and expenses per member for the years 1900-59. Dues for Associate Member after 6 years are shown by the red line cutting across the income and expenses bars. It is readily evident that in only 9 of 58 years have dues been equal to expenses and income per member.

Considering the increase in activities, publications, services, and inflation, dues have remained remarkably constant dollarwise. Possibly no service nor commodity except electric energy has increased so little in price in 75 years as have Institute dues.

Fig. 5 shows our sources of income[9] for 1957-58. Institute services are shown to be directly proportional to income, half of which is from dues. In his own interest, therefore, every member should consider himself an *ex officio* member of his Section Membership Committee.

Fig. 6 shows our expenses[9] for 1957-58. Some of these expenditures are obvious, others may require a note of explanation.

Publications, the main artery of communication with members and the permanent record of Institute papers and activities, account for half the expenditures. These include all costs for the preparation and distribution of *Electrical Engineering, Transactions,* bimonthly publications, preprints of papers, Membership Directory, Organization Manual, and miscellaneous special committee and technical conference publications.

General and Administrative expenses include salaries not directly charged to specific activities, social security taxes, retirement system, insurance, office supplies, printing, telephone and telegraph, postage, travel, and depreciation; and legal, financial, and audit services.

Technical Committees expense includes salaries and services charged to special technical conferences and other technical activities, and publication of standards, part of which is recovered in succeeding years (see Fig. 5, Standard Sales).

General Committees costs include primarily public relations and membership activity.

Outside Activities expenses include assessments and dues from joint-society activities.

Business Machine Conversion includes the initial cost of converting member records, dues, publication orders, technical interests, etc., to business-machine cards. It is hoped that eventually these modern methods will effect over-all savings in the business office.

The Reserve Capital Fund was $1,198,479 (book value) as of April 30, 1959. It is considered desirable that this fund be at least sufficient to meet one year's operating expenses, since income can decrease under unfavorable economic conditions much faster than expenses can be contracted. Also, it is necessary to accumulate a fund to defray moving expenses to, and furnishings for, the new United Engineering Center.

As soon as practicable, an endowment fund should be created so that the Institute's operations, particularly publications, will not be dependent upon economic cycles.

SECTIONS

Sections have been said to have originated in 1893, when members located at inconvenient distances from New York expressed a desire for assemblies at other locations, and the Chicago meetings were first held. Actually, Sections as we know them were not formed until 1902, when they and Branches were organized under the title, "Local Branches." Sections were separated and given their present name in 1907.

Fig. 7 shows the remarkable growth of our Sections organization over a 52-year period. As Section activity expanded, so did our organization.

Subsections were an outgrowth necessitated by the need for additional meetings. The phenomenal increase of Subsections may also be noted in Fig. 7.

Technical Groups were formed to provide Section members with an opportunity to confer on special topics within their home area. During recent years, greater co-operation has been effected between the Institute Technical Committees and the Section Technical Groups.

Section programs vary greatly. About the only general statement that may be made is that technical meetings and social gatherings are usually featured. Since the Sections are autonomous, their programs reflect the interests and energy of members within each individual Section.

Educational courses are offered in some of the larger Sections. Subjects may be technical, semitech-

Table III. Annual Institute Medals and Awards

Title	Established	Sponsored by	In Honor of	Field of Achievement
Edison Medal	1904	Friends of Thomas A. Edison	Thomas Edison	Electrical science or electrical engineering or the electrical arts
Electrical Engineering Education Medal	1956	Members-for-Life Fund	—	Electrical engineering education
Fortescue Fellowship	1939	Westinghouse Electric Corporation	Charles L. Fortescue	(for graduate study in electrical engineering)
Habirshaw Award	1958	Phelps Dodge Foundation	William A. Habirshaw	Electrical transmission and distribution
Kelly Award	1959	Bell Telephone Laboratories, Inc.	Mervin J. Kelly	Telecommunication
Lamme Medal	1924	Bequest from Benjamin G. Lamme	—	Electrical apparatus or machinery
Leeds Award	1958	Leeds & Northrup Foundation	Morris E. Leeds	Electrical measurement
Sarnoff Award	1959	Radio Corporation of America	David Sarnoff	Electronics

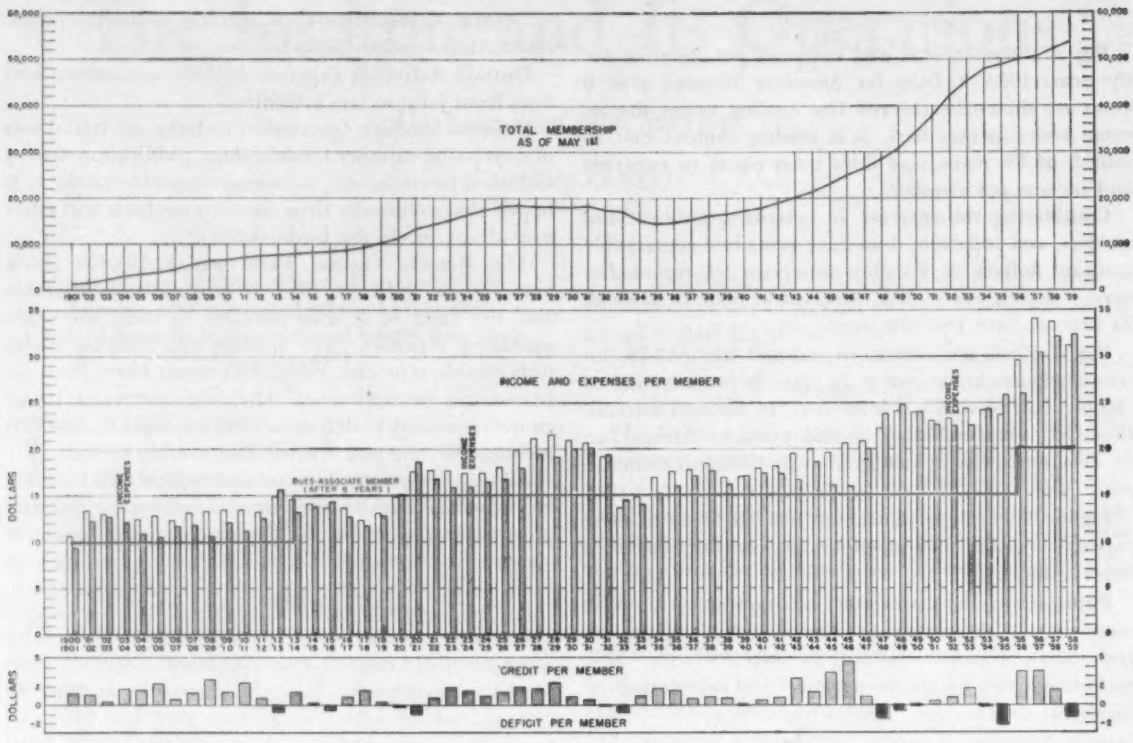


Fig. 4. Income and expenses per Member—1900-59.

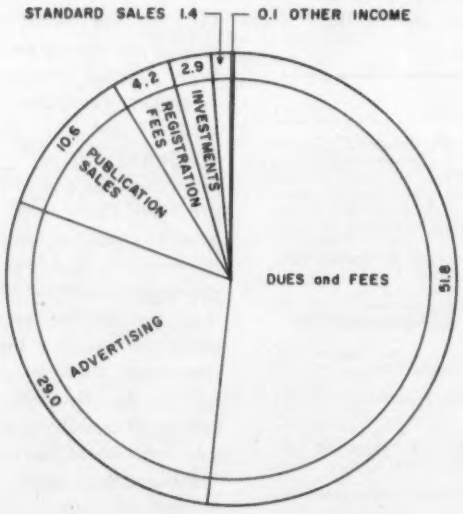


Fig. 5 Income (per cent) 1957-58.

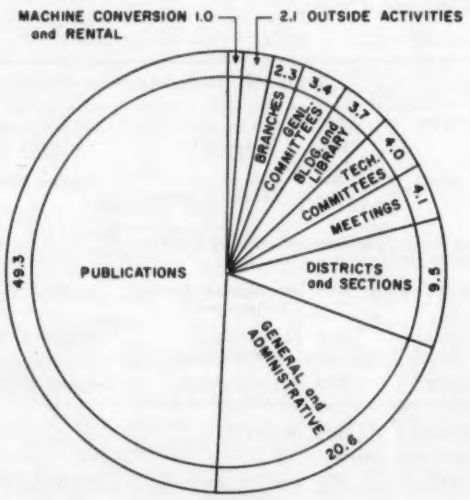


Fig. 6. Expenses (per cent)—1957-58.

nical, or directed at personal development, such as public speaking. Co-operation with other society groups within the Section is often effected. Sections encourage nearby Student Branches, sometimes joining with them to sponsor programs of mutual interest. Vocational guidance to young people is undertaken in some areas. Technical discussions on matters of local interest may be conducted. Participation in civic affairs related to engineering is encouraged.

STUDENT BRANCHES

Fig. 7 shows the constant increase in Student Branches since their formation in 1907.

Enrolled Students were offered *Transactions* and other privileges at small expense as long ago as 1903. The Student Badge was authorized in 1907. Today, Student Members receive a subscription to *Electrical Engineering*, and a bimonthly publication of their choice at a reduced rate. For 1958-59, $107,710 were expended for Student activities.

Table III shows prizes awarded each year for the best student paper on Section, District, and Institute levels.[10]

Student Branches are autonomous, each planning and conducting its own program of activity. Each Branch has a Counsellor, who is a member of the District Student Activities Committee which, in turn, is represented on the Institute Student Branches Committee. These Committees devote their full efforts toward improving the Branch operations.

AIEE Student Branches provide the Student Member with a fine opportunity to broaden his training beyond text-book knowledge, and to keep abreast of developments in *all* phases of electrical engineering. They result in the development of friendships among future fellow members of his profession, who after graduation are likely to scatter over different geographical areas, and to enter various fields of practice. Such contacts can be very helpful careerwise, and provide social enjoyment throughout an engineering career. AIEE provides a line of contact after graduation, and a common meeting ground. Older members who have formed and retained such relationships through AIEE cite this as an outstanding Institute service.

TECHNICAL ACTIVITIES

Standing committees were appointed in June 1884 to cover apparatus and subjects of the time. Early committees were short-lived, the organization changing from year to year.

The oldest technical committee of the present type is Transmission and Distribution, which began in 1902 as a subcommittee of the Meetings and Papers Committee.

From 1902 through 1914, there were no technical committees, as such. There were, however, an increasing number of "special committees" of a technical nature.

From 1915 through 1946 technical committees were autonomous, such co-ordination as was required being effected within the Technical Program Committee, of which each committee chairman was an *ex officio* member.

Fig. 8 shows the yearly number of technical committees from 1902 through 1959. From this, it is apparent that the Board of Directors' action in 1946 to expand technical committee activity was eminently successful.

In the Technical Operations Department are three of the Institute's General Committees. The Research Committee has undertaken a program to increase new research in the universities through the Engineering Foundation. The Safety Committee constantly seeks awareness of safety considerations, and is working toward uniform requirements of the National Electrical Code and the Canadian Electrical Code. The Standards Committee is revising the Standards Manual, encouraging development of standards in areas not yet

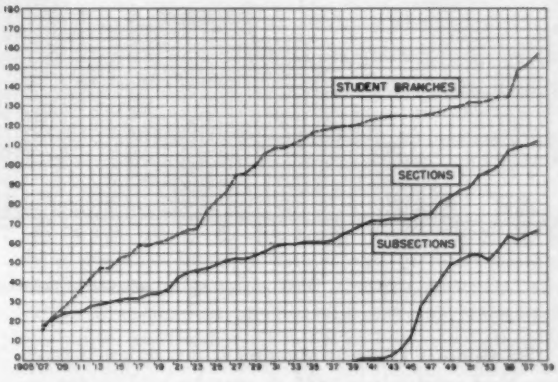


Fig. 7. Number of Sections, Subsections, and Student Branches as of May 1.

adequately covered, and seeking to improve the effectiveness of AIEE co-operation with the American Standards Association.

INSTITUTE MEETINGS

Institute meetings today consist of General Meetings, District Meetings, and Special Technical Conferences.

General Meetings

The **Pacific General Meeting** was initiated in 1911. Every 3 or 4 years, the Summer and Pacific General Meetings combine to meet in District 8 or 9, which together make up the entire West Coast area.

The **Fall General Meeting** is the youngest, having first been held in 1947. Chicago is the standard location, except for every 5 or so years when it is scheduled in another midwestern location.

The **Winter General Meeting**, first held in 1913, has become our largest and best attended. It is held in New York City except for once every decade or so when it is scheduled for another eastern location.

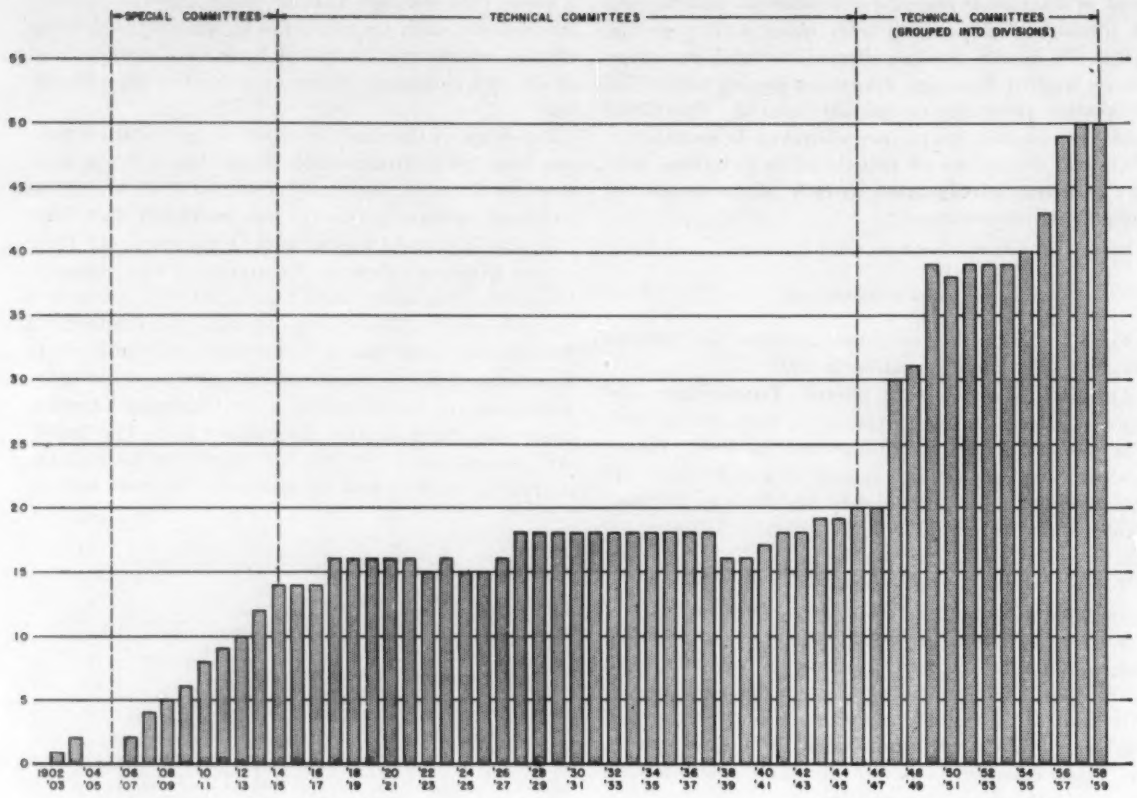


Fig. 8. Number of Technical Committees—1902-59.

The **Summer General Meeting** is our oldest, having been held yearly since 1885. It may be held at any location.

The **Annual Meeting** for conducting Institute business has been held coincidentally with the Summer General Meeting since 1905.

Technical programs for General Meetings are arranged by the Technical Operations Department. General and social events are planned by the General Meeting Committee.

District Meetings

The **District Meeting** resulted from the formation of Districts in 1921, the first of this type of assembly having been held in 1924. Decisions to hold such meetings are made by the individual Districts. The Technical Operations Department co-ordinates location and dates. Institute policy confines the scheduling of District Meetings to the Spring, from March 15th through May, to avoid conflicts with regularly scheduled meetings both in and outside the Institute.

Technical programs for District Meetings are arranged by the Technical Operations Department, when the Districts so request. Otherwise, papers are obtained from within the District by the District Meeting Committee, which also arranges the general and social aspects of the program.

Special Technical Conferences

The **Special Technical Conference** was inaugurated in 1948 for the benefit of specialists among Institute members. These meetings feature papers on a single theme, and are sponsored jointly with other society groups when the subject is of mutual interest. So popular are these Conferences that in 10 years the number had increased from 2 to 28.

PUBLICATIONS

Regularly issued publications of the Institute include the magazine, *Electrical Engineering*, published monthly; technical papers with discussions, published in 3 separate parts, issued bimonthly; cloth-bound *Transactions* in 3 separate parts, issued annually.

Special Publications, advance copies of papers, a Membership Directory, an Organization Manual, and various operational guides and leaflets also are published.

Electrical Engineering

Since 1887, the Institute has published continuously for distribution to the entire membership a journal, currently called *Electrical Engineering*. Title and format have been changed from time to time. Title changes have been:

Years	Titles
1887-1904	Transactions (of monthly meetings)
1905-1919	Proceedings
1920-1930	Journal of AIEE
1931-Present	Electrical Engineering

Advertising was first accepted in 1903.

General interest information augmented technical paper content starting in 1920.

Membership demand for more such features combined with publication costs to cause printing of condensed versions, or digests instead of full texts of papers. More and more space was devoted to Institute activities and news of developments in engineering and the allied arts and sciences. Thus, *Electrical Engineering* evolved into its present form.

Transactions

Publication in book form of papers, discussions, and meeting transactions was among the recorded aims when the Institute was organized. This aim was fully accomplished, and we now have a permanent historical record of electrical science and engineering through 75 consecutive years.

The first bound *Transactions* was issued as vol. V, covering meetings from November 1887 through September 1888. Vols. I-IV, if returned to the Secretary, would be bound into one book at "an expense not exceeding $1.25, plus 25¢ postage."

Calendar year *Transactions* were first published in 1889, vol. VI including the preceding three months of 1888.

Discussion has always been published, sometimes with papers, at other times separately. Since 1947, discussion has been correlated with papers.

In 1952, the present system of divisional *Transactions* was instituted. Papers are classified according to subject, and published in one of three parts:

Part I	Communication and Electronics
Part II	Applications and Industry
Part III	Power Apparatus and Systems

Bimonthly Publications

Each *Transactions* Part is issued bimonthly in paper binding. Members may subscribe to one or more of the three bimonthly publications, and thus accumulate through the year content of the volume or volumes of the annual cloth-bound *Transactions* in which they are most interested.

Advance Copies of Papers

In 1894, when the Institute was 10 years old, it was recorded that the plan of printing and distributing to the entire membership advance copies of papers read before meetings was carried out "as thoroughly as possible." The quoted phrase would indicate that even then, this aim was difficult to achieve. Since that time, membership has increased more than 60 times, the yearly number of *Transactions* papers has increased 15 times, new informal types of papers have come into use, and publication costs have skyrocketed. In spite of these and other factors, progress is being made toward making available *all* papers for members who wish them.

Other Publications

Special Publications, the S- and T-numbered series, contain material of special value within a limited field; e.g., bibliographies, symposia, conference proceedings.

A Membership Directory is printed for sale to members only.

An Organization Manual, now published yearly, is an operational guide for members engaged in Institute activities. It contains the Constitution, Bylaws and Policies, Officers and geographical territories of Districts and units within the Districts, Department and Committee personnel and scopes, meeting schedules, statistical compilations, and other useful data.

Various Manuals, Guides, and leaflets are issued as required by organizational units throughout the Institute.

PROFESSIONAL DEVELOPMENT

The Institute's activities in professional, as distinguished from technical, development are handled largely by joint councils or through other societies (see Part III). To take care of intra-Institute matters in this area, several General Committees are maintained.

Education Committee

The Institute serves as a Post-Graduate School for its members.[11] Its interests extend also to undergraduate curricula. As long ago as 1892, the first papers on education were read at an Institute meeting. Charles P. Steinmetz, as President of AIEE in 1902, used electrical engineering education as the theme of a major address.[12]

The Education Committee originated in 1907. It has sponsored papers, held special meetings, issued publications, and co-operated with outside groups concerned with educational matters through 52 years of activity.

With increased interest in educational matters on a national scale, our Education Committee has stepped up and broadened its work. One of its many projects at present is the formulation of a proposed Policy Guide on Electrical Engineering Education, including secondary school preparation.

Professional Conduct Committee

Engineering honor was the subject of an address by President Schuyler Skaats Wheeler in 1906.[13] It was suggested that the ideas he expressed be embodied in a code of ethics for the engineering profession. Such a Code was prepared in 1907, and was discussed, revised, set aside, reactivated, and finally adopted by the Board of Directors in March 1912.[14]

The Code was first invoked in 1921-22, when the Committee recommended resignation in the case of a member's presentation of false information, and severe censure and withdrawal of a publication which used the Institute's name without authorization.

Now called the "Statement of Principles of Profes-

sional Conduct of the AIEE," the last revision was adopted by the Board of Directors in August 1950.[15]

Registration of Engineers Committee

Since 1911, an Institute committee has been charged with handling matters regarding registration and licensing of engineers. It has worked with outside organizations in developing licensing provisions. It has encouraged the Sections to help State Boards prepare questions for examinations, and to conduct refresher courses.

In June 1957, the Committee recommended and the Board approved[16] a "Policy on Registration of Engineers."

Management Committee

In 1947, a Committee on Management was formed. It is concerned with the engineer's relationship to management, and works toward better understanding between the two. It encourages engineers to study the art of management on their own initiative, and points out the need for engineers to view engineering projects from a business as well as a technical standpoint.

The Committee arranges sessions at General Meetings. In March 1956, with ASME, it initiated an annual 2-day Conference on Engineering Management, which in September 1959 will be joined by the other Founder societies.

Public Relations Committee

In 1945, a Public Relations Committee was organized on the basis that a sound publicity program not only stimulates membership growth, but also enhances the prestige of members and the profession as a whole.

Table IV. Paper Prizes and Awards

Best Paper	First Prize	Second Prize	Other Prize
Institute			
In Technical Division (each of 6)	$100 and Certificate	Certificate*	Certificate*
In General Committees or Electrical Engineering	$100 and Certificate		
By Undergraduate Student	$100 and Certificate		
District (each of 13)			
By Resident of District	$75 and Certificate	$50 and Certificate	
By Undergraduate Student in District	$25, Certificate, and All Expense Trip to Summer General Meeting§		
Section (each of 112)			
By Section Member	$100 apportioned by Section ($50 maximum prize) and Certificate		
Branch (each of 160)			
By Undergraduate Student in Branch	$10, Certificate, and Trip to District Student Prize Paper Competition	Certificate	

*Awarded at discretion of Prize Awards Committee.
§Authorized by Members-for-Life Fund Committee in January 1944.

Since 1949,[16] the Committee has engaged the services of a public relations consultant, who works with the Committee to provide year-round publicity for the aims and accomplishments of the Institute. These two co-operate to furnish material for Meetings, and leaflets and Newsletters for distribution by and to the Sections.

PROFESSIONAL RECOGNITION

Recognition of outstanding achievement within the Institute is given by conferring special grades of membership, and awarding medals and prizes. In addition to its own awards, the Institute participates in several joint awards with other societies (see III in series).

Membership Grades

Honorary Membership is conferred by unanimous election of the Board of Directors for "meritorious service to mankind in engineering or other fields." The first to have been so honored was Sir William Preece on October 21, 1884, within a few days after our first technical meeting. In 75 years, only 45 have achieved this grade, of whom 6 are living.[18]

Fellow grade is conferred by election of those Members who have "attained distinction" in the fields of engineering, education, invention, research, and management of engineering enterprises. As of May 1, 1959, 1,572, or 3% of the membership, held this grade.

Medals and Awards

Table III shows the medals and awards given within the Institute each year.

Table IV shows the prizes for best papers awarded by the Institute.

HEADQUARTERS SERVICES

The Headquarters Staff of 90 persons is under the general direction of the Executive Secretary. In addition to the business office and field service, the Staff includes Divisions on admissions and transfers, professional development and recognition, publications, and technical operations.

Business Office

Under direction of the Office Manager are grouped accounting, member records, Membership Directory, order and billing, nonmember subscriptions, and office services such as clerical, typing, business-machine operation, addressograph, and shipping.

Field Service

An Assistant Secretary serves the Administration Department and Standards Committee. He also maintains the Section and Branch records, and edits the Organization Manual, Annual Report, Constitutional amendments, election ballots, operational guides, and similar material.

Admission and Transfers

The Secretary to the Board of Examiners collects and reviews all individual files of applications and references for admission and transfers, and proposals for Fellow grade, for submission to the monthly meeting of

the Board. He also handles all enrollment of Student Members and their transfer to Associate Member grade. For 1958-59, the Board acted upon 11,814 applications for admission or transfer in grade.

Professional Development and Recognition

A staff member serves the Committees of the Professional Development and Recognition Department, including the handling of all medals, awards, prizes, and certificates.

Publications

An Editor and Manager of Publications, assisted by an Associate Editor, Editorial Assistants, regional Advertising Managers, and editorial and clerical staff, issues all Institute publications.

Technical Operations

An Assistant Secretary, Technical Papers, with clerical assistance, handles all authors' manuscripts from submission through review by Technical Committees to publication as preprints. He compiles the mailed announcements and programs for General and District Meetings. He is also Secretary of the Prize Awards Committee.

An Assistant Secretary, Technical Activities, with clerical assistance, handles the recommendations for personnel of the 6 Divisions and 50 Technical Committees received from several sources, and provides staff service to all Special Technical Conferences. He also assembles Conference Proceedings for publication.

Reorganization

On June 27, 1958, the Board of Directors authorized a reorganization of the Staff to parallel the departmental organization of the Institute, together with addition of personnel necessary to proper functioning.

(The third and concluding article in this series, subtitled "III. Inter-Society Affairs," will appear in the August 1959 issue of Electrical Engineering.)

REFERENCES

8. Membership Directory, 1958-59, p. 588.
9. Report of Board of Directors, 1957-58, p. 38.
10. Institute Prizes, AIEE *Organization Manual for 1958-59*, pp. 188-89.
11. AIEE Is a Post-Graduate School, L. F. Hickernell, *Electrical Engineering*, May 1956, pp. 476-77.
12. Presidential Address, Charles P. Steinmetz, AIEE *Transactions*, vol. XIX, 1902, pp. 1145-50.
13. Engineering Honor: President's Address, Schuyler Skaats Wheeler, AIEE *Transactions*, vol. XXV, 1906, pp. 241-68.
14. Code of Principles of Professional Conduct of the AIEE, AIEE *Transactions*, vol. XXXI, pt. II, 1912, pp. 2227-31.
15. Statement of Principles of Professional Conduct of the AIEE, *Electrical Engineering*, Feb. 1951, pp. 171-73.
16. Policy on Registration of Engineers, Resolutions, June 28, 1957; AIEE *Organization Manual for 1958-59*, p. 158; *Electrical Engineering*, Sept. 1957, p. 812.
17. Committee on Public Relations, Report of Board of Directors, 1949-50, AIEE *Transactions*, vol. 69, pt. II, pp. 1690-1716 (1695).
18. Honorary Members, AIEE *Organization Manual for 1958-59*, p. 172.

Saturn Rocket Engine

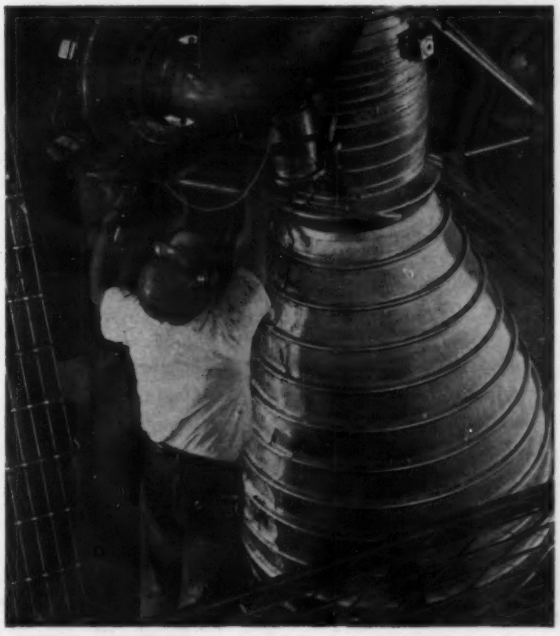
The first Saturn rocket engine—a liquid propellant single unit that will be used in groups of eight to produce 1.5 million pounds of thrust in a giant space missile—has been delivered to the Army Ballistic Missile Agency (ABMA) by Rocketdyne, a Division of North American Aviation, Inc.

Under development by ABMA at Redstone Arsenal, Ala., Saturn is expected to enter flight test in 1960.

The modified engine for Saturn, developed from existing components of advanced Jupiter and Thor missile engines, operates with RP-1 (a kerosene-type fuel) and liquid oxygen, the propellant combination used by most of today's missiles. Propellants are fed by twin turbo-pumps to the combustion area of the engine.

In the booster vehicle, each engine will operate independently. The four outer engines of the eight-engine grouping, however, will be movable to direct the course of the giant missile. Those engines will be mounted on gimbals—a part of their assembly—and moved by signals from the guidance system.

Designated *H-1* by Rocketdyne, the modified engine is being tested at the company's Propulsion Field Laboratory in the Santa Susana Mountains in California.



Linearization of Deadspace

SHELDON JONES
ASSOCIATE MEMBER AIEE

DISCONTINUOUS NONLINEARITIES such as static friction, hysteresis, and saturation exist in most physical systems. Extensive theories have been developed for the analysis of this type of nonlinearity. The most common of these theories are those of the phase plane and the describing function. Unfortunately, these theories do not contribute substantially to the synthesis of physical systems of any complexity.

A method is outlined for linearization of deadspace or backlash with ideal components. In practice, the method will convert discontinuous nonlinearities to continuous nonlinearities.

An inspection of Fig. 1, block G2, indicates that over a region corresponding to an input signal of small amplitude no output is obtained; for inputs of larger magnitude an output is obtained. This suggests that if the signal were superimposed on a square-wave carrier proportional to the deadspace, the effect of the deadspace could be minimized. Another method of accomplishing the same thing is to provide infinite gain in the region of zero signal and finite gain for other amplitudes. The characteristics of such a device are shown in Fig. 1, block G1.

When the two nonlinearities are connected in tandem, as in Fig. 1, it can be shown that for $a_2 = b_2$ and $a_1 = b_1$

$$y(t) = K \times (t)$$

The input–output relationship exhibited in Fig. 1, block G1, can be achieved by building an amplifier with infinite open-loop gain and operating the amplifier open loop–closed loop as a function of output voltage. That is to say, feedback could be applied to the amplifier at a certain magnitude of output voltage.

When two diodes are connected "back-to-back," the input–output relationship is as shown in Fig. 1, block G2, where current is considered the output and voltage is considered the input.

A device of this type was tested experimentally in the feedback loop of an amplifier and the results are plotted in Fig. 2. The amplifier, a low-gain amplifier, was chosen because of availability.

Fig. 2, curve *b*, is a plot of output vs input when the amplifier was operated as a linear amplifier driving a nonlinear load. With the Zener diodes in the feedback loop, the input–output relationship of the nonlinear amplifier driving a linear load is shown in Fig. 2 curve *a*. When the nonlinear amplifier was used to drive a device with deadspace, the input–output relation of Fig. 2, curve *c* was obtained.

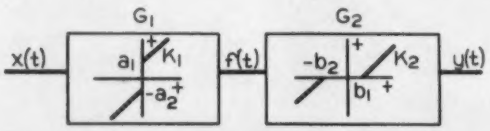


Fig. 1. Block diagram of deadspace and nonlinear driver.

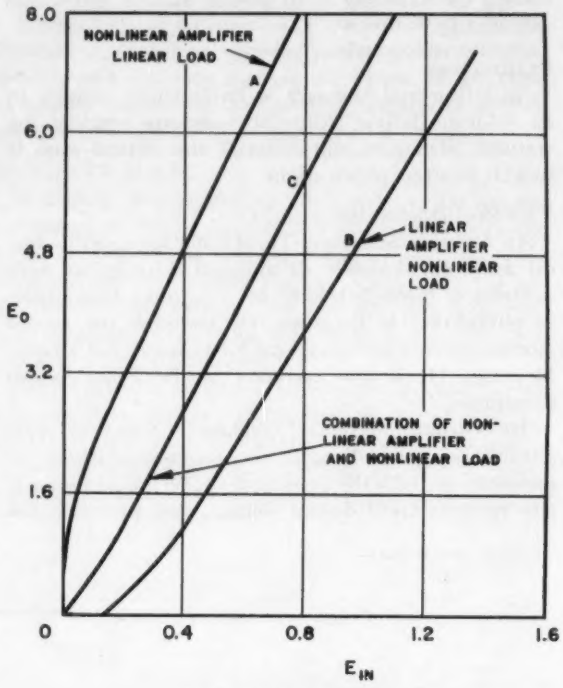


Fig. 2. Experimental data.

In a system with deadspace, the use of a nonlinear amplifier such as has been described yields the following advantages:

1. Improves the stability of the system and minimizes the possibility of low-level oscillations.
2. Increases the sensitivity in the low signal region.
3. Tends to linearize the input–output relationship of the open-loop system.

The conversion of the discontinuous type nonlinearity to a continuous nonlinearity allows the designer to base stability prediction on linear analyses. In addition to this, the designer of position feedback systems has more latitude in choosing the output feedback point.

Digest of paper 58-1174, recommended by the AIEE Electronics Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Communication and Electronics*, Jan. 1959.

Sheldon Jones is with the Hughes Aircraft Company, Culver City, Calif.

Aluminum and Its Future in Power Transformers

W. W. ORR
MEMBER AIEE

DURING THE EARLY 1940's copper was in short supply in many countries, with the result that aluminum came into use in power transformer windings as a means of conserving copper. Since that time, there has been a continued interest in aluminum for transformer use. Considerable literature has been published on the use of aluminum in reactors, dry-type transformers, and distribution transformers. Less data has been available on the use of aluminum in power transformers above 10,000 kva. It is these larger sizes that are now under study.

Two ratings of aluminum-winding transformers were built and tested, one is rated 37,000 kva and the other, 71,000 kva. To give an accurate comparison, copper-winding transformers were designed to the same ratings, impedance, and total losses.

Tables I and II show comparable weights and dimensions of transformers using copper and aluminum windings. The increase in weight is consistent for both ratings and should hold true for most power transformers over 10,000 kva. These tables also show comparative costs. The transformer cost is very dependent on the base price of aluminum and copper. The tables use a copper base price of 26.5¢ per pound to the producers while the aluminum pig ingot price is 28.1¢ per pound. There would be an infinite number of base prices for aluminum and copper conductor where both the aluminum and copper transformers have equal cost. This break-even point is shown in Fig. 1. For example, if the base price of copper was 45¢ per pound, then the aluminum base price would be 27¢ per pound for the 71,000 kva units and 22¢ per pound for the 37,000 kva transformers for equal cost. Fig. 1 is based on a constant spread between the base price and the price the transformer manufacturer pays for the drawn bare conductor. A change in this spread would have the same effect on the over-all transformer cost as would a change in the base price.

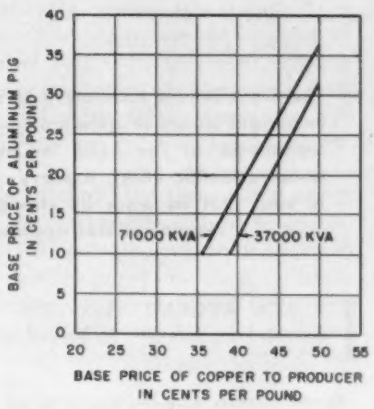


Fig. 1. Break-even point for aluminum or copper conductors in power transformers.

There is no difficulty in designing and building power transformers with aluminum windings. The future of aluminum for this purpose will depend on the availability and relative price of aluminum and copper conductors. Using recent prices of aluminum at a base price of 28.1¢ and copper at 26.5¢ per pound, the aluminum-winding transformer is about 4% higher in cost than one using copper. If the price of copper increased or aluminum prices decreased, then the 4% would be reduced and the two transformers would approach equality in cost. While these conclusions apply to power transformers over 10,000 kva, they do not necessarily apply to transformers of smaller kva, air-cooled transformers, or reactors.

Table I. Comparison of Transformers Having First Rating*

Items	With Copper Windings	With Aluminum Windings	Increase Over Copper
Weight of core and coils, pounds	70,000	72,600	4%
Weight of tank and fittings, pounds	32,400	33,800	4%
Weight of oil, pounds	51,000	53,600	5%
Total weight, pounds	153,400	160,000	4%
Width, inches	219	227	8
Depth, inches	194	198	4
Height over cover, inches	170	175	5
Height over bushings, inches	302	307	5
Impedance, per cent	13	13	0
No-load loss, kw	65.3	72.1	10%
Total loss at 70 C, kw	216	216	0
Noise level, decibels	79.0	79.9	0.9
Factory cost, per cent	100	104.5	4.5

* Rating: 37,000 kva, 55 C, forced-air cooled, 60 cycles, 275,000 grounded-Y/158,770 to 13,200 volts.

Table II. Comparison of Transformers Having Second Rating*

Items	With Copper Windings	With Aluminum Windings	Increase Over Copper
Weight of core and coils, pounds	96,600	101,500	5%
Weight of tank and fittings, pounds	31,000	32,200	4%
Weight of oil, pounds	55,100	57,800	5%
Total weight, pounds	182,700	191,500	5%
Width, inches	213	223	10
Depth, inches	153	158	5
Height over cover, inches	181	184	3
Height over bushings, inches	291	294	3
Impedance, per cent	11	11	0
No-load loss, kw	94	105	12%
Total loss at 75 C, kw	400	400	0
Noise level, decibels	83	84	1.0
Factory cost, per cent	100	104.2	4.2

* Rating: 71,000 kva, 55 C, water cooled, 60 cycles, 301,400 grounded-Y/173,990 to 13,200 volts.

Digest of paper 58-881, recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Published in AIEE *Power Apparatus and Systems*, Dec. 1958, pp. 978-81.

W. W. Orr is with the Canadian General Electric Company, Ltd., Guelph, Ont., Canada.

The Role of Government Research Laboratories

A. V. ASTIN

The Government laboratory is one of the most important assets of national science. Within the framework of the need for an enlarged national scientific effort, it plays a unique role. It is vital that its work be strengthened and its responsibilities appreciated.

IN ITS RECENT REPORT on "Strengthening American Science," the President's Science Advisory Committee stated:

> In the 13 years since the end of World War II, science and technology have pushed to the forefront of national life with an urgency that no Congress or President serving in the first 4 decades of this century could have imagined.

I think it may be readily admitted also that no scientist could have anticipated the force and vigor of modern science, especially with respect to its impact on the Nation.

Today, a significant portion of the Federal budget is devoted to research and development, and these funds are augmented by an increasing investment in science on the part of industry, education, and philanthropic foundations. Today, there is growing recognition that the future of this nation is directly related to the results and progress of American science. Today, more than ever before, the planning, management, and decisions affecting the course of national growth are dependent upon the fruits of scientific investigations. And today, we appreciate more than ever before that the economic, industrial, educational, military, and medical advancement of the United States are inexorably linked with an effective national science program. We must recognize this relationship, but even more we must take those steps which will provide for a broad and active pursuit of technical eminence. In this context it is important to restate the Science Advisory Committee's encouragement to all elements of the American scientific community—industrial laboratories, university laboratories, research institutes, and Government laboratories—all elements to contribute to a substantial strengthening of this nation's research effort. "It is vital," says the Committee, " to the future growth of American science that all these components participate in the support and encouragement of research."

Now, in providing for an enlarged national research program, there are a number of policy problems which deserve the consideration of appropriate technical groups. Current questions which must be resolved are: What is an optimal level of basic research in Federal programs, in an industrial laboratory, and in a Government laboratory? How can we provide for adequate and imaginative coverage in all of the physical, engineering, and medical sciences? How can we establish a proper balance between Government and private research programs? And, finally, how can we strengthen the scientific programs of Government, whether they be done in its own laboratories or in Government-contract operations?

Essentially full text of a talk given at the session "The Road to Scientific Supremacy," held at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959.

A. V. Astin is director, National Bureau of Standards, Washington, D. C.

UNIQUE RESPONSIBILITY

THERE ARE, of course, still other important problems, but it is my purpose here to direct your attention to one special area: the role of the Government research laboratory. Within the framework of the need for an enlarged national scientific effort, the Government laboratory has a unique responsibility, a responsbility which frequently cannot be delegated and often has a critical relationship to the actions of Federal agencies. In these days of scientific emphasis, it is somewhat disturbing that the work of Government laboratories is often misunderstood and sometimes unappreciated. Not only has the growth of science added to the burden of Government laboratories, but misunderstanding about Government in-house programs have hampered the effectiveness and continuity of this work and, at times, lowered the morale of dedicated scientists in the public service. The special problems of Government research laboratories and Federal scientific and engineering personnel deserve the penetrating attention of those concerned with the progress of American science.

WORK OF THE GOVERNMENT LABORATORY

I WOULD LIKE first to deal with a description of the work and value of Government research laboratories. Except where specifically authorized to undertake more general programs, the work of most Government laboratories is undertaken in relation to the mission specifically assigned to the parent agency. In this context, Government laboratories provide technical assistance to agency executives by conducting scientific activities related to the agency's mission, by giving technical evaluation to scientific activities outside of the agency which have a bearing on its mission, and by assisting in the interpretation of scientific progress which bears upon executive planning and decision. In the class of responsibilities just listed, you will note the direct relationship

of laboratory work to assisting improved judgment at the executive level.

It is very likely that the closer the contact of senior Government officials, either civilian or military, with relevant scientific activities the greater will be their opportunities for exploiting science and technology in the fulfillment of their public responsibilities. These opportunities will hold whether the officials are charged with the defense of our country, the protection and promotion of public health, the conservation and development of our natural resources, the promotion of industry or agriculture, or the regulation of complex technical business activities.

In the defense area, for example, it is difficult to imagine how the U.S. Army, Navy, or Air Force could provide adequately for the common defense without a capability for deciding what is required to establish vigorous and imaginative new approaches for needed technical equipment, to select technically qualified contractors for research and development, engineering and production, and to evaluate materiel and service. The research laboratories of the defense agencies are most important elements in making such a capability possible, but the mere existence of such laboratories is not enough. They must first of all be highly competent and then there must be close interchange of ideas and personnel between the laboratories and the planning and decision-making levels of these agencies. Similar situations hold, in varying degrees of scope and urgency, in all the other Government agencies whose programs and missions involve technological matters.

Research has frequently been characterized as beginning with a state of mind: a willingness to accept change, an urge to do things better tomorrow than they are being done today. Such a state of mind is essential to the progressive improvement of the vital services which the Federal Government must perform. Highly skilled research centers with vigorous, mission-oriented programs would seem a minimum requirement to have the research state of mind permeate our Federal establishment. This, I believe, is the primary justification for the Government's research laboratories.

There is however, an additional justification which applies to many of the Government's laboratories, such as those of the Geological Survey, the National Bureau of Standards, and the Food and Drug Administration. These agencies deal respectively with our primary national material resources, the basic standards and techniques for physical measurement, and the safeguarding of national health. Such areas are so fundamental to the general welfare of the country that research results and associated technical services clearly belong in the public domain. I believe it is in the public interest that the Government conducts the core of such technical activities in its own laboratories with its own staff.

I have touched upon the matter of competence in the Government's laboratories and now plan to discuss it in some detail. This matter is very closely associated with the theme of this symposium: the road to scientific supremacy. The important responsibilities and opportunities I have ascribed to the Government laboratories cannot be effectively fulfilled without high quality.

COMPETENCE A VITAL NEED

THE VALUE OF BUILT-IN COMPETENCE to the major scientific and technological decision-making processes of government is probably readily appreciated. It is somewhat more difficult to appreciate the urgency of competence in some of the older, and seemingly less glamorous civilian scientific agencies. Here superficial observers are apt to conclude that the programs are well established and quite routine and that a mediocre effort will suffice.

Let us consider, for example, the agency with which I am most familiar—the National Bureau of Standards. Many of the uninformed, including even some scientists and engineers, look upon the job of providing the standards for physical measurement as a static and unexciting technical activity involving routine skill and patience. But let us consider briefly the nature of the job of providing such standards.

Reliable standards for physical measurement are essential to the efficient interchange of data among scientists of components and material of specified properties throughout industry, and of goods in commerce. No measurement data can be effectively exchanged unless the units and standards in terms of which the data are expressed are known and usable, at least to the accuracy of the measurement data involved.

Hence, those responsible for the standards must excel in measurement techniques. Furthermore, there are continual demands to improve the accuracy of measurements and to extend measurement competence to the frontier areas of science and technology. Thus, the standards must be continually refined and extended. And this requires a high order of scientific imagination and skill. A special committee named by the Secretary of Commerce several years ago to appraise the Bureau's program made the following observation:

> It is not sufficient to have fairly good standards of measurement; fairly good methods of testing materials, mechanisms or structures; or reasonably good determination of important physical constants. The standards, the measurements, the test procedures must be the very best, the most accurate, the most reliable that can possibly be achieved at any given time, limited only by the state of art at the time.

I believe that similar appraisals of the importance of excellence can be made for almost all of the Government's research laboratories. It is fair to conclude that if a scientific task is important enough to entrust to the Federal Government it is important enough to demand the highest practicable skills.

There is another reason why I believe it important that we seek to improve the quality and efficiency of the Government's research laboratories. This involves a sound balance of the total national effort among university, industrial, and Government laboratories. I have no plan to offer as to what this balance should be except to observe that the balance would be impaired if Government responsibilities were transferred to private or-

ganizations because of present inadequacies in Federal laboratories. These inadequacies should be dealt with forthrightly. I am sure that most of us have heard arguments that such and such a Government activity should be contracted for as the best way of assuring that a sufficiently high quality staff will be assembled for the job to be done. Very often this shows an understanding of a Government laboratory problem but provides for a dangerously warped solution. It is important for the planning of new technical programs, where new facilities have to be created or special skills have to be assembled, that existing Government laboratories be in a position qualitywise to undertake those tasks which are close to the central responsibilities of Government.

I can think of no way more certain to bring about the deterioration of our Government laboratories than a situation which would favor the placing of all exciting new research programs outside of Government. No scientist worthy of the name would want to stay with an organization where the major frontier areas were closed to him.

FACTORS IN EFFECTIVENESS

I WOULD NOW LIKE TO DISCUSS a few of the factors important to the maintenance and enhancement of the competence and effectiveness of the Government's laboratories. First, and closely related to the preceding topic, is the matter of "mission." Every laboratory should have a clearly defined mission closely related to the mission of its parent agency or to an essential function of Government. The mission should be specific enough to provide purpose, focus, and urgency to a laboratory program yet broad enough to encourage creativity and unhampered thinking. Few factors are more important in attracting and holding first-rate minds than the opportunity of applying advanced thinking and techniques to problems which may have an important bearing on a significant objective. Within Government, it is essential that each laboratory's mission be sufficiently distinctive to differentiate its program and objectives from those of other laboratories yet not be so restrictive as to preclude some work in related and overlapping areas. If a mission is too broad, it is difficult to achieve or demonstrate significant accomplishment. Furthermore, if staff members can work on anything under the sun, the program tends to be diffuse, thus detracting from the assigned mission of the agency. On the other hand, if the areas of work are too vigorously defined, originality may suffer and a laboratory program could easily become static and routine.

The problem has been noted by the President's Science Advisory Committee when it said, "A mission, clearly stated, will greatly help a laboratory to plan and execute a vigorous and imaginative program." The Committee went on to say that a clear mission statement would help in providing a "better balance between . . . in-house research and that performed outside of Government."

This problem of a mission statement is neither semantic nor trivial. Nor is it easy. At the National Bureau of Standards, for example, we have been giving considerable attention to an improved mission statement for several years. Although we have made some progress, there is still much room for improvement. It is my conviction that a sharper yet dynamic mission formulation would enable us to develop programs that would contribute more effectively to the Nation's technical progress and at the same time permit the staff to enjoy a greater sense of participation in significant objectives.

The next area for consideration is that of laboratory direction. Here, I think, prime emphasis should be placed on the selection of an effective director—a leader who understands the problems of his staff and who has their confidence. The director should be given considerable responsibility and matching authority for the planning and operation of the laboratory programs over a long-time period and in terms of objectives which he has developed. It is disastrous to underestimate the role of the laboratory director or to reduce his effectiveness by following a practice of short-term appointments or rotation of responsibility. The nature of research and development is such that long-term continuity is essential to permit carefully planned programs to be carried through to completion and evaluation. This is sometimes a problem for laboratories in the Department of Defense. To heighten the concept of leadership, I will quote from the "Report on Improving Government Laboratories" of the Science Advisory Committee of the Office of Defense Mobilization.

> Everyone knows what leadership is, although few will define or describe it well. The leadership here required is not solely in the laboratory, which itself is vital, but equally important in the "management" above the laboratory. Leadership in the management is more than picking a good laboratory director and paying him a decent salary. It is largely a matter of isolating the principal functional jobs to be done—the comprehensible and important ones—and giving the laboratory director the responsibility for carrying through the research and development necessary to solve the technical problems of those functional jobs.

Probably the greatest area needing attention has to do with improving the administrative conditions for in-house research, particularly with respect to the conditions for keeping and making best use of high quality scientists. Our interest is to make the Government's scientific laboratories and staff as productive as possible, that is, to achieve a maximum output of new scientific ideas and data. To achieve this, we should place the scientist in the best physical and psychological position for doing his job. This means giving him ready access to information, providing him with opportunities to increase his competence, and setting up the conditions for concentrated activity without distraction. Now, to the degree that we are able to provide improved conditions and personnel practices, to that degree will the efficiency, productivity, and creativity of Government laboratories be improved. I do not intend to deal any more extensively with this situation than I have, except for mentioning four special problems: First, the Government still is in a poor position to recruit the best of the

newly graduated scientists. A major difficulty is that under present Civil Service regulations the Government is generally unable to offer any more, in terms of starting salary, to the top man of a graduating class than to the bottom man. Fortunately, some relief was given to this problem by the last Congress for recruiting new college bachelors but this needs to be extended to include holders of masters degrees and Ph.D's. We must be able, in special situations, to pay premium entrance rates for quality. This is important. Without it, we will fail to enlist a fair share of the best of the new talent so necessary for continued effectiveness. The second problem is that we are unable to reward the most important of our top technical personnel adequately. It just is not good personnel practice to force our most able people to continue their dedicated service at what could be considered a financial loss. Third, we must find new and simplified ways by which Government scientists have greater opportunities for working with interesting ideas, getting them approved, and finally participating in their implementation. In some cases we are beginning to suffer from "channelitis" and compartmentalization. Here also it is essential that there be adequate delegation both of responsibility and of matching authority. And fourth, it is necessary that we examine the organizational and service framework of Government laboratories with respect to the needs of research and research personnel. At the National Bureau of Standards, our shops, our administrative operation, our supply activity, and our special services are oriented to meet the technical program activities. More of this is needed, with special emphasis on the pride and participative spirit which is cultivated in supporting personnel.

A year ago I would have added a fifth problem in this area—namely, the need for means to provide specialized training for selected staff at institutions of higher learning and elsewhere. Fortunately, the last Congress enacted a liberal training law so that Government agencies now have the opportunity to advance their competence through effective training programs.

I have attempted in this talk to demonstrate that the Government research laboratory is one of the most important assets of national science. Its relationship to the total technical activity is critical from these points of view: for its special research activity and its contribution to the advancement of research and development; for its technical assistance to the Government in furthering specifically assigned Federal missions; and for its service in assisting in the evaluation of other research activities of the country. The Government laboratory is an essential part of the national research effort. For this reason it is especially important that its work be strengthened, with the emphasis on quality, and that its responsibilities be appreciated. In terms of what still has to be done in bolstering our country's technical effort, there is ample opportunity for co-operative growth of all elements of the scientific community.

I would like to conclude with a final point. The responsibility for strengthening the Government laboratories does not rest solely with those in the Government service. As public institutions, we belong to the people of this country and our work is of most immediate concern to the Nation's scientists and engineers. Hence, all taxpayers have a direct stake in our work and the more knowledgeable scientific community has a special opportunity through constructive criticism, consultation and support to assist in making our Government laboratories a source of national strength and pride.

Radar Pictures from "Edge of Space"

A highly versatile radar system, developed by Sperry Gyroscope Company and now standard equipment aboard U. S. Air Force troop, cargo, and jet tanker planes, has been identified as that used by the Air Research and Development Command (ARDC) to demonstrate for the first time how radar operates at extreme altitudes.

The U. S. Air Force reported that the radar pictures were taken from the gondola of an unmanned 2 million-cubic-foot free balloon soaring 100,000 feet above the earth. Equipment and pictures were returned safely to earth. The flight was conducted for ARDC by the Goodyear Aircraft Corporation and the Winzen Research Corporation. The radar was modified by these companies for this specific purpose. According to an ARDC official, the unusual pictures will extend man's limited knowledge of radar characteristics at stratospheric altitudes.

To obtain the radar impressions, a camera trained on the radarscope recorded the changing display on film. Simultaneously, another camera recorded aerial views to provide exact identification for co-ordination of the radar picture and the land below. The films themselves are still classified.

The navigation-type radar employed displays a visual, map-like scope picture showing cities and smaller terrain features, rivers, islands, mountains, shorelines, and ships at sea. When used as a weather radar, it displays less substantial objects such as storm fronts, heavy rainfall, and other turbulent weather features with precipitations. The small lightweight radar in these tests is used by the Air Force for search and surveillance, storm detection, and other all-weather navigation purposes.

This radar set development was the result of a joint engineering and flight research program of the U. S. Air Force and Sperry's Air Armament Division.

Telex in New York

P. R. EASTERLIN
MEMBER AIEE

By means of Telex, an automatic dial teleprinter exchange service, New York City subscribers may now obtain direct teleprinter connections to more than 1,200 subscribers in Canada. The subscriber set, the Canadian network, means of connection, charges, and operation of the exchanges are described.

AN AUTOMATIC DIAL TELEPRINTER exchange service was placed in operation in May 1958, by means of which subscribers in New York City may obtain direct teleprinter connections, in a matter of seconds, to over 1,200 subscribers in Canada.

The new service, internationally known as "Telex," incorporates the characteristic automatic answer-back feature which confirms that the proper dial connection has been made and that transmission, even to unattended stations, is being correctly recorded on the distant teleprinter. The same subscriber equipment also can be used to connect to the land-line and cable tie-line sections to send and receive public message traffic.

The Telex Exchange at Western Union is linked by a number of carrier telegraph channels to the Montreal exchange of the Canadian Telex network. The Canadian Telex service, comprising over 100,000 miles of telegraph trunk facilities, was placed in operation in July 1957 jointly by the Canadian Pacific and Canadian National Telegraph Companies, and its operation has been presented in an unpublished paper by C. J. Colombo of Canadian Pacific Telegraph Company.

SUBSCRIBER SET

IN NEW YORK, the Telex subscriber set consists of a console-mounted type *15* teleprinter and an associated remote control (dial) unit shown in Fig. 1. A call is made simply by depressing a start button and dialing a 5- or 6-digit subscriber number. The connection is made immediately after the last digit has been dialed. The fact that the connection has been made is indicated by the teleprinter motor starting and an operate lamp lighting. The connection can be terminated from either end by depressing a stop button, which turns the equipment off. If the called subscriber is already engaged, a busy signal is returned which cuts the calling subscriber's equipment on for a second, then off again.

Answer-Back Feature. The teleprinter keyboard in the subscriber set is equipped with an answer-back unit, a close-up of which is shown in Fig. 2. This device is a cylindrical drum associated with the keyboard which can be coded to transmit an answer-back sequence of 19 characters, 14 of which can be used to identify the subscriber's name and city as listed in the Telex directory. The unit is remotely actuated by the WHO ARE YOU signal (FIGS. and D keys) sent from the distant end, or it can be triggered locally by depressing an associated HERE IS key.

In normal operation, the calling subscriber initiates the exchange of answer-back sequences after a dial connection is established by transmitting the WHO ARE YOU signal, receiving the answer-back from the distant teleprinter and then depressing the HERE IS key to identify himself to the called subscriber. An exchange of answer-backs also may be initiated at any time during transmission to verify continuity in reception or as an over-all acknowledgment just prior to terminating a call. The answer-back, along with a paper-out protective circuit which prevents a connection being made to a subscriber's teleprinter having low paper, provides a high degree of reliability for Telex connections to unattended subscriber stations.

Subscriber Set with Local Tape Function. For Telex subscribers who require the additional operating facility of preparing, transmitting, or receiving on a 5-channel perforated tape, a special type of subscriber set is provided. This set, as shown in Fig. 3, is equipped with a Siemens model *100* page printer which has a built-in reperforator and transmitter–distributor attachment. A special type *L* remote-control unit is provided which allows the printer equipment to be used in an "off-line" manner for the advance preparation of tape. In the event of an incoming Telex call, the subscriber set is automatically switched "on-line" after a

Fig. 1. Telex subscriber set.

Condensed text of paper 59-37, presented at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Recommended for publication by the AIEE Telegraph Systems Committee. Published in AIEE *Communication and Electronics*, May 1959, pp. 194-201.

P. R. Easterlin is with The Western Union Telegraph Company, New York, N. Y.

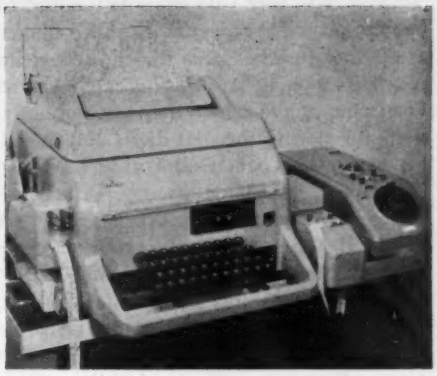


Fig. 2 (left). Answer-back unit installed on keyboard of type 15 teleprinter. Fig. 3 (right). Subscriber set with local tape function.

warning signal. Specifically, the set provides the following operation:

1. Off-line operation when idle, enabling the keyboard to be used for preparation of tape from reperforator attachment, along with a printed monitor copy.

2. After a connection is established, transmission may be from either the keyboard or by tape fed through the transmitter–distributor. Outbound, as well as inbound, transmission is again recorded on the page printer and the reperforator attachment may be used simultaneously to produce another tape.

The page printer used in this set also contains a 2-color ribbon feature which automatically prints the outgoing transmission from the keyboard and the incoming transmission in different colors. This is very useful when a 2-way Telex conversation is later transcribed or read by other parties.

CANADIAN TELEX NETWORK

THE LAYOUT of the Canadian Telex network and the interconnection to the New York Telex exchange is shown in Fig. 4. The network is divided into three areas, centralized around a junction exchange in each area. These are Area 01, Montreal; Area 02, Toronto; and Area 03, Winnipeg. Other exchanges such as New York (015) are designated as district exchanges and are assigned three digits; the first two represent the junction area and the third digit denotes the district exchange within that area. The subexchange, which is usually in a nearby city to the district exchange, functions as an integral part of its respective district exchange by the assignment of a different fourth digit. For example, 036 designates the Vancouver, B. C., district exchange and 0366 switches a call through to a subexchange located at Victoria, B. C.

Local subscribers connected to the various junction and district exchanges are assigned either 5- or 6-digit dial numbers such as 03-564 for a Winnipeg subscriber or 015-222 for a New York subscriber. The digits on the right side of the hyphen denote the local number which is dialed to reach another subscriber who is terminated in the same junction or district exchange as the calling subscriber. For long-distance connections—calls to subscribers terminated by other junction or district exchanges—all the digits, i. e., 03564, must be dialed.

While the Telex exchange equipment used in Can-

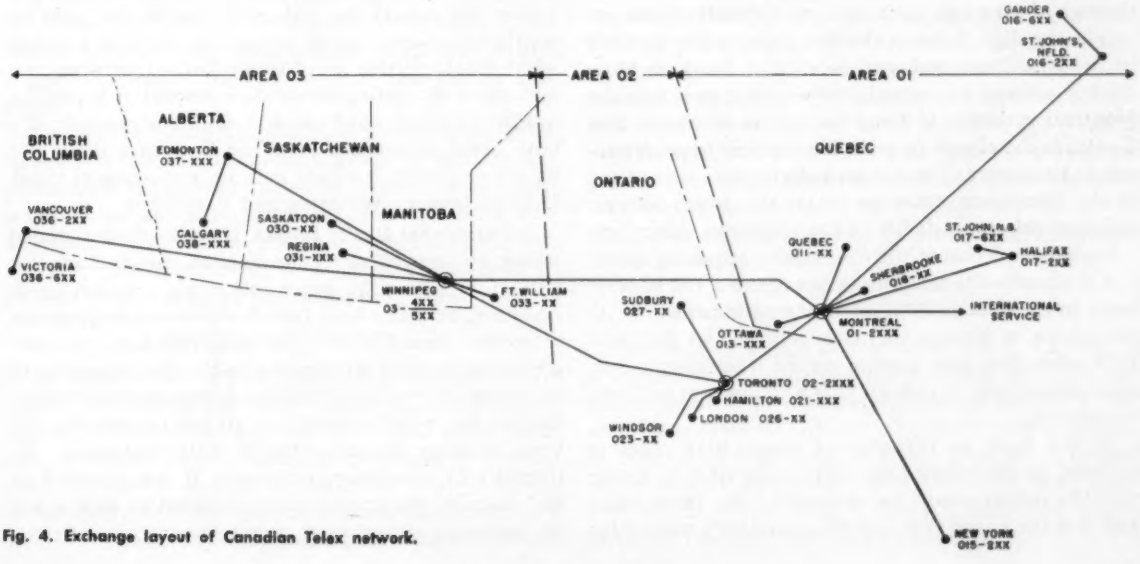


Fig. 4. Exchange layout of Canadian Telex network.

ada and New York City employs the direct dial, or step-by-step, principle and completes the connection as soon as the last digit has been dialed, it does impose certain restrictions on the routing of calls over trunk circuits. For example, the system does not normally employ registers for storing the dial digits and selecting alternate routes for calls when all trunks are busy or faulted. Therefore, each long distance call between two exchanges, excluding the subexchange, is given a predetermined route through one or more junction exchanges. For example, a New York call to Vancouver is routed New York–Montreal–Winnipeg–Vancouver and could not be passed through an additional Telex exchange such as Montreal–Toronto–Winnipeg, etc. Also, calls between local subscribers in subexchanges must be handled through the respective district exchange.

HOW A TELEX CONNECTION IS ESTABLISHED

BEFORE a description is given of the technical functions of the switching equipment in the Telex exchange, the various steps which take place in establishing a long distance Telex connection will be explained. Assume, for example, that a New York subscriber dials 036-292 to reach a subscriber in Vancouver, B. C. The connection through the group selector switches and repeater equipment in the various Telex exchanges for such a call is illustrated in simplified form in Fig. 5.

When not in use, the teleprinter motor in the subscriber set is turned off and the dial on the remote control unit is locked. To initiate a call, the New York subscriber depresses a start button which causes the subscriber's preselector switch in the Telex exchange to seize an idle group selector switch. Almost instantly, the exchange equipment returns a "go ahead dial" signal to the subscriber, unlocking the dial and bringing up a white visual indicator located in the remote control unit.

The subscriber dials 036292. While these digits are being dialed, the circuit is progressively built up through the various exchanges to Vancouver. For example, the digit 0 causes the first group-selector switch in the New York exchange to select a trunk to Montreal; 3 actuates the second group-selector switch in the Montreal exchange to route the call to Winnipeg and 6 extends the circuit in a similar manner from Winnipeg to Vancouver. The last three digits, 292, are utilized in the Vancouver exchange to set the group selector and final selector switches to the respective subscriber.

Upon completion of the connection—requiring about 7 or 8 seconds—the teleprinter motor and a red operate lamp on the Vancouver subscriber set are turned on. As this occurs, a free-line signal is returned to the New York subscriber, also turning on the teleprinter motor and operate lamp to indicate that a connection has been established.

At this time, an exchange of answer-back codes is initiated by the calling (New York) subscriber to insure that the proper automatic connection has been made and that the called (Vancouver) subscriber's teleprinter is functioning properly. The following typical operating sequence shows how the answer-back feature is used at the beginning and end of a Telex connection. Shown in parenthesis is the control character which triggers the distant subscriber's answer-back unit and the symbols for the teleprinter nonprinting functions, i.e., ← carriage return, ≡ line feed, ↑ figure shift, ↓ unshift.

Description of Operating Sequence		Characters Received by Both Teleprinters	
WHO ARE YOU (Sent by calling subscriber)	(↑ D)		
ANSWER BACK (Sent automatically by called subscriber)	(←≡↓)	SCOTIA BANK VCR	(←≡)
HERE IS (Sent by calling subscriber)	(←≡↓)	CHASE BANK NYK (Telex message or 2-way teleprinter conversation)	(←≡)
WHO ARE YOU (Sent by calling subscriber prior to disconnecting)	(↑ D)		
ACKNOWLEDGMENT (Sent automatically by called subscriber)	(←≡↓)	SCOTIA BANK VCR	(←≡)

Without respect to the originator of a Telex call, the subscriber at either end of the circuit may terminate the connection at any time by depressing the stop key on the remote control unit. When this occurs, the trunk-circuits through the several exchanges are released sequentially, beginning at the exchange of the originating or calling subscriber. This turns off the teleprinter motor and operate lamp on both subscriber sets, making them available for initiating or receiving other connections.

Busy Signal. After a subscriber who is already engaged in a connection is dialed, a busy signal will be returned which momentarily turns on and off the teleprinter motor and operate lamp of the calling subscriber and relocks the dial. Also, a subscriber may receive a busy signal before completing the dial sequence when trunk circuits are busy or faulted between two exchanges. By dialing slower than normal, it is possible to identify the blocked trunk section. For example, if a busy signal is returned after the first three digits 036 have been dialed, it would indicate a shortage of trunk facilities between Winnipeg and Vancouver.

Subscriber Set Out of Service. If a subscriber is dialed whose equipment or connection to the exchange is faulted, or where the paper roll is too low and needs replacing, neither a busy (which may be misleading) nor a free-line signal is returned and, therefore, the subscriber set receives no response to the dial sequence. In such cases, the calling subscriber is requested to depress the stop key, which cancels the call and recycles the dial unit, enabling the subscriber to redial and report the difficulty to supervisory personnel. If not canceled in this manner, the trunk circuits involved in such a call are automatically released after a short period of time.

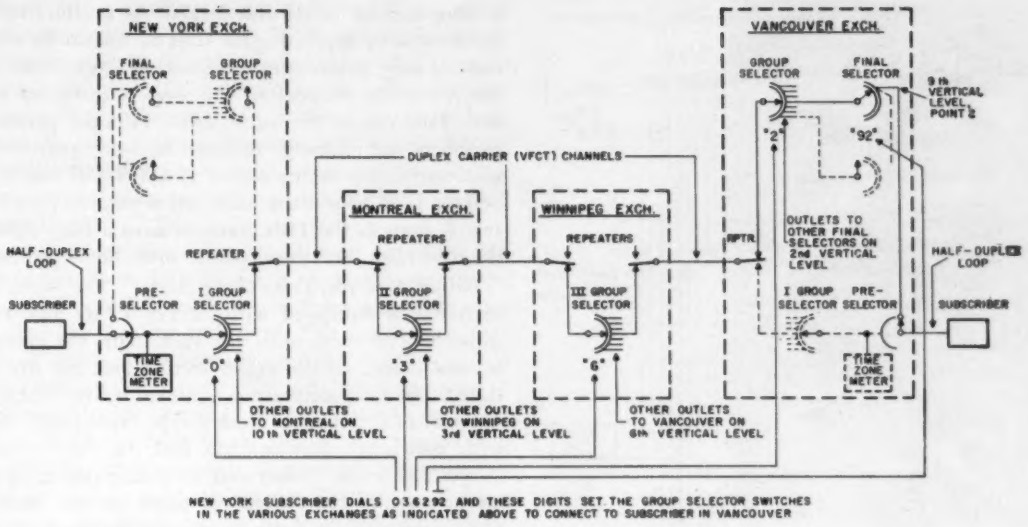


Fig. 5. Build-up of connection through several Telex exchanges.

PUBLIC MESSAGES OVER TELEX

THE EXCHANGE EQUIPMENT is arranged so that Telex subscribers can make free calls to the land-line or cable tie-line sections to send or receive public message traffic. As such connections are established, the subscriber or the telegraph company initiates an exchange of answer-back codes by following the regular Telex operating procedure. This speeds up the movement of message traffic by eliminating the delay in obtaining acknowledgments.

By dialing 1 or 3, respectively, the New York subscribers are automatically connected to one of a group of page receiving only positions in the land-line tie-line section at New York, or to similar positions in the cable office. The receiving-only teleprinters are coded with the WHO ARE YOU signal following the Western Union Telegraph Company answer-back sequence. Therefore, as a subscriber calls in and obtains the Western Union answer-back, the subscriber's answer-back unit is also triggered automatically to identify the calling subscriber.

Messages or cablegrams destined for the local Telex subscribers are handled from a group of sending-only positions in the tie-line sections of the two offices. These positions are also equipped with a remote-control dial-box unit and the operator simply dials the subscriber's number, obtains an answer-back before and after transmission of each message series, and then disconnects.

INFORMATION CENTER

AN INFORMATION CENTER is located in the land-line tie line section which New York subscribers can reach by dialing 9. This center communicates with other information centers in the Canadian exchanges to provide subscribers with current additions or changes in the Telex directory and to exercise general supervisory control over Telex network operations. Canadian exchanges may connect to the New York information center by dialing 015-9.

TELEX CHARGES

There is no minimum time charge for individual Telex calls between New York City and Canadian subscribers. Instead, there is a flat connection charge of 50¢ for each completed call, plus a particular pulse rate—based on airline mileage—which is applied for the actual time the connection is held intact. The pulse rate, having no relation to the telegraph transmission speed, is expressed in ppm (pulses per minute) and the charge for each pulse is 2½¢. In addition, there is a $35 monthly charge for the subscriber equipment. There is no charge for calls to Western Union other than the regular rate for telegrams or cablegrams.

For example, a pulse rate of 15 ppm is applied for a New York City–Montreal call and 30 ppm for a New York City–Vancouver call. Therefore, the connection and pulse rate charge for a 1-minute New York City–Montreal call is 50¢ + (15 x 2½¢) or 87½¢ and for the New York City–Vancouver call it would be 50¢ + (30 x 2½¢) or $1.25. If these calls were held for a 2-minute period, the charges would be $1.25 and $2, respectively. The connection and pulse rate charges are assessed to the calling subscriber on two 5-digit counters individual to each subscriber line.

TELEX EXCHANGE OPERATION

NEW YORK, as well as the exchanges in Canada, is equipped with a switching system which has been specially designed for teleprinter exchange service. While employing different circuitry, the system uses a number of equivalent telephone exchange functional components such as preselectors, group selectors, final selectors, repeaters, etc. Fig. 6 shows a simplified theory layout of the New York Telex Exchange.

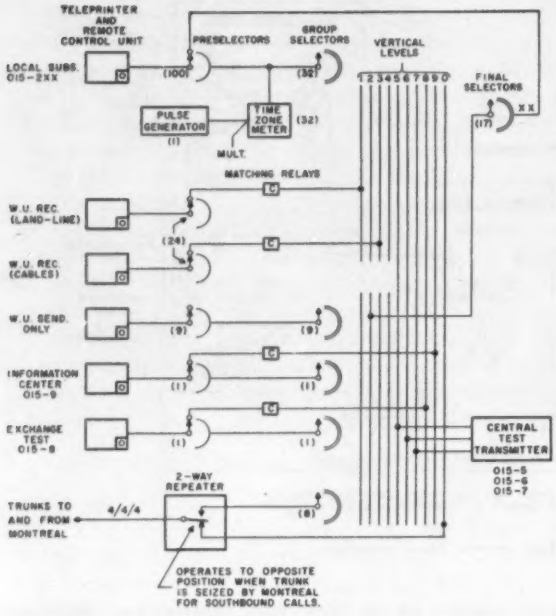


Fig. 6. Theory of New York Telex exchange. (Note: Figures in parentheses denote the number of exchange units of each type.)

The operation of the exchange equipment will be covered by describing the functions which occur for setting up the typical New York City—Vancouver call, previously used in the brief explanation of how a Telex connection is established. The description for a northbound call, outgoing from New York and incoming at Vancouver, also will be typical of southbound calls from various Canadian exchanges to New York. Photographs of the exchange equipment units also will be referred to at appropriate points throughout the discussion. The multiple wiring and grouping arrangement of the equipment is not essential to a preliminary understanding of the exchange operation and is discussed later.

Preselectors. Fig. 7 shows a group of preselector racks where the loop from each subscriber is terminated. Each subscriber's preselector consists of control equipment located in a subscriber bar and an associated preselector (stepping) switch capable of connecting to any one of 10 GS/TZMs (group selectors/time zone meters). Each of the first three preselector racks accommodates 40 local subscribers (or tie-line positions) which are operated on a loop basis using make-break signaling. A different type of preselector rack, serving 20 long-distance subscribers, has additional control equipment for operating 2-wire polar over physical or carrier facilities for longer distances. In the latter case, a d-c converter panel is required at the terminal of the distant subscriber to provide an equivalent termination between the line facilities and the conventional subscriber loop.

When the subscriber's set is idle, a current of about 5 ma (milliamperes) flows in the loop in a direction to keep the teleprinter motor cut off and the subscriber's remote control (dial) unit locked. As a subscriber initiates a call by depressing the start button on the remote control unit (equivalent to removing a telephone from the hook) the current in the loop is increased to 60 ma. This causes the subscriber's 11-point preselector switch in the exchange to leave its home position and seek connection ot any one of 10 GS/TZMs which may be idle. If all 10 of these units are in use, the preselector switch steps to the 11th point, returns a busy signal to the subscriber, and then restores to its home position.

Group Selector/Time Zone Meter. The New York exchange is equipped with 32 GS/TZMs and Fig. 8 shows five of these units per rack, with the group selectors located in the upper section and the five associated time-zone meter units mounted below. The group selector is a 2-motion decade-type (stepping) switch with associated relay controls and the switch, having 10 vertical levels (rows) and 10 rotary points in each level, provides 100 outlets for three circuits, SEND, RECEIVE, and TEST, the latter for control purposes.

The associated time-zone meter is for the purpose of recording, by means of two stepping switches and associated relay controls, the first four dial digits, or less, in order to apply the proper charge for each call. In doing so, the proper metering pulse-rate conductor is picked up from the pulse-generator and passed back over a separate conductor through the preselector switch to the subscriber's two individual connection and pulse-rate counters. After the dialing sequence and when a free-line signal has been given to the calling subscriber, which indicates a completed call, both counters are stepped on a prepulse and, thereafter, only the pulse-rate counter responds to the metering pulses obtained from the pulse-generator rack. The TZM can be strapped to cancel and return a busy signal on certain calls which are to be rejected for special reasons. Also calls to the tie-line or information positions at New York are recognized by this unit as free calls, for which neither counter is allowed to operate.

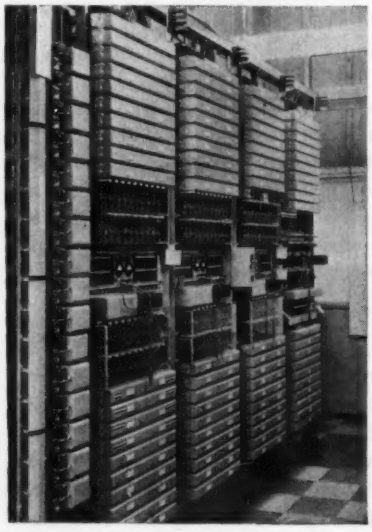


Fig. 7 (left to right). One rack of 20 final selectors, three racks of 40 local preselectors, and one rack of 20 long-distance preselectors.

When the subscriber's preselector switch has made connection with an idle GS/TZM, which is almost simultaneous with the release of the "start" button, a go-ahead dial signal is returned to the subscriber set. This signal is an interruption in the subscriber's loop current for about 25 milliseconds, which unlocks the dial unit and brings up a white visual indicator in the remote control unit, providing an indication that dialing can begin.

As the subscriber begins the dialing sequence, the group-selector switch in the GS/TZM is operated by the dial pulses of the first digit, which for a long-distance call would be 0 to the 10th level. The switch then free-hunts or self-steps horizontally over the 10 rotary points on this level and stops on the first idle point corresponding to an outgoing or 2-way trunk repeater to the Montreal exchange. A busy signal also will be returned to the subscriber at this point if all available trunk circuits are in use. Between the dialing time of the first and second digits, the trunk circuit to Montreal is tested by means of a revertive pulse which is described in the following paragraphs on the Telex trunk repeaters.

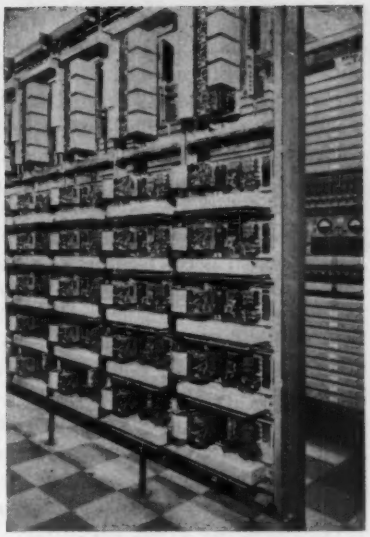


Fig. 8. Group selectors/time-zone meters.

Telex Trunk Repeaters. The 12 trunk circuits which connect to the Montreal exchange are terminated in three types of repeaters designated as incoming, 2-way, and outgoing. These repeaters permit the trunk circuits to Montreal to be operated on a 4/4/4 basis, which notes the incoming, 2-way, and outgoing seizure priority for establishing a Telex connection. For example, the four incoming trunk circuits may be seized only for southbound calls, the four 2-way circuits for calls in either direction, and the four outgoing circuits for northbound calls only. A jack field and associated control for testing individual trunk circuits is located in the center of the rack.

In addition to the switching controls for seizure of the trunk circuits, each repeater contains two polar telegraph relays which repeat the telegraph signals and dial pulses on a 2-wire polar basis between similar telegraph relays in the subscriber's preselector located in the exchange and the sending and receiving legs of the carrier-channel terminal equipment. When a trunk circuit is unseized, the spacing (positive) polarity is applied in both directions.

Returning now to the typical northbound call, as the GS/TZM, previously described, stops on the point of an idle outgoing or 2-way repeater after the first digit has been dialed, the sending leg of the carrier trunk circuit to Montreal is reversed to the marking (negative) polarity. This seizure signal is received in the Montreal exchange on an incoming or 2-way repeater having an associated group selector. If the trunk facility and group selector equipment is in proper working order, the Montreal repeater returns a revertive pulse of approximately 25 milliseconds to the New York exchange. Reception of this signal in New York momentarily operates the receiving relay in the Telex repeater to the marking polarity and then back to spacing, verifying circuit and equipment continuity for the reception of dial digits. Failure to properly test a trunk circuit in this manner instantly produces a busy signal to the calling subscriber, removes this particular trunk circuit from service, and operates an exchange alarm.

As the second and third digits are dialed by the New York subscriber in the typical 036-292 call to Vancouver, the second digit, 3, sets the group selector at Montreal, as shown in Fig. 5, to the third vertical level, where it free-hunts, seeking an idle outgoing or 2-way repeater to Winnipeg. When the connection is made to such a repeater, the trunk circuit between Montreal and Winnipeg likewise is tested by means of the revertive pulse, as previously described. Following this the third digit, 6, is used in a similar manner at Winnipeg to extend the call to Vancouver. The call now enters the Vancouver exchange in an incoming or 2-way repeater having an assigned group selector which is pulsed by the fourth digit, 2, to the second vertical level. Between the dialing time of the fourth and fifth digits, the group selector free-hunts over the rotary points in level 2 and connects to the first idle final selector.

For each 100 subscriber lines in an exchange, a rack of 20 final selectors, as shown in Fig. 7, is provided for handling incoming calls to this group of subscribers. The final selectors also use the 2-motion decade-type 100-point stepping switch and associated relay controls, but unlike the group selectors, they do not free-hunt in a horizontal direction. Instead, the final selectors are pulsed vertically and then horizontally by the remaining two dial digits to make connection to anyone of 100 subscribers served by this rack.

As the group selector seizes an idle final selector and the dial digits 92 are received in the Vancouver exchange, the circuit is extended to the called subscriber's preselector switch. If the Vancouver subscriber is idle, as indicated by the preselector switch being in the home position, the relay controls of the preselector function to reverse the 5 ma flowing in the loop. This reversal of current actuates the polar motor-control equipment in the subscriber's set, which turns on the teleprinter mo-

tor, operate lamp, and also increases the loop current to the 60-ma working level.

Provided the loop current has been raised to the working level, the called subscriber's preselector in the Vancouver exchange will now return the free line signal to the calling subscriber's preselector in the New York exchange. This is a reversal of transmission polarity from spacing to marking in the eastbound direction. As this signal is received at New York, the 60-ma current flowing in the calling subscriber's loop is reversed, causing the teleprinter motor and operate lamp to be turned on and the dial unit to be shunted from the loop circuit. As the connection is completed, the calling subscriber's connection counter is stepped one unit and the associated pulse counter begins recording the assigned pulse rate charge for this call. Starting of the calling subscriber's teleprinter motor now permits the exchange of answer-back sequences previously described.

Disconnecting. Either the calling or called subscriber may terminate a Telex connection by depressing the STOP key on the remote-control unit for about a second. This transmits a steady spacing polarity to the distant end, longer in length than normal teleprinter signal combinations. Regardless of which terminal such a disconnect signal emanates from, it is recognized by the calling subscriber's preselector—in this case New York—which in turn transmits a steady spacing signal through the GS/TZM, outgoing or 2-way repeater at New York, through the Montreal, Winnipeg, and Vancouver exchanges. This signal effects a release of the trunk circuits and switching equipment in the various Telex exchanges in the same sequence in which the connection was originally established. As the disconnect takes place, the subscriber sets at both ends of the circuit are restored to the idle condition by having the teleprinter motor and operate lamp turned off and the dial unit at the calling station relocked.

Dialing Western Union. Referring to Fig. 6, the local position preselectors are connected through matching relays *C* directly to specified levels on the GS/TZM switches, effecting a savings in final selector equipment. As a New York subscriber dials 1, 3, etc., the GS/TZM switch is stepped vertically to the proper level where it then free-hunts and connects to the first idle position.

OTHER EXCHANGE EQUIPMENT

THE FOLLOWING PARAGRAPHS will describe briefly the operation and arrangement of other equipment in the exchange not explained in the foregoing description of a typical connection.

Pulse Generator. The various pulse rates, one of which is picked up by the time-zone meter for each chargeable call to step the subscriber's pulse-rate counter, is supplied from the pulse-generator rack, containing two pulse generators (one working and one fallback), a changeover frame, and 18 output relays, producing various outputs from 1 up to 36 ppm. In case of equipment failure, the companion pulse generator is automatically placed in operation.

The individual pulse generator consists of two polar telegraph relays having an *R-C* (resistor-capacitor) oscillatory circuit adjusted for a basic output frequency of 360 operations per minute. This output is used to drive several groups of switching relays in a frequency-reducing network which, in turn, drive 18 output relays corresponding to the required pulse rates. For the pulse and no-pulse intervals, a combination of negative battery and ground potential, respectively, is applied from the contacts of each output relay to the various pulse rate leads which connect to the time zone meters. The absence of this combination for any length of time enables an automatic pulse-control monitor to detect an open circuit, short circuit, or ground on any of the pulse leads.

In addition to the tariff function, a selected number of these pulse leads are used, instead of electronic timers, to actuate alarm and control circuits for abnormal exchange functions. For example, when a subscriber depresses the start button and does not dial a number, the exchange equipment is restored to normal after about 3 minutes by a control circuit which absorbs three of the 1-ppm pulses.

Central Test Transmitter. The New York exchange is equipped with a central test transmitter, which automatically transmits a choice of three types of tests for the use of maintenance personnel in checking local subscriber equipment or transmission over Telex trunk circuits. The characters for the test transmission are programmed by relays from a drum-type distributor and each test can be transmitted simultaneously to five different lines.

When the digits 5, 6, 7, respectively, are dialed from a local subscriber set, the following tests are continously provided by this transmitter:

1. A printing test utilizing all the lower and upper case teleprinter characters.
2. An unbiased "quick brown fox" sentence.
3. Five lines of "quick brown fox" in which one half of the sentence is alternately spacing and marking bias. Each line is prefixed with 0, 20, 30, 35, or 40% to indicate the amount of bias being transmitted.

Canadian exchanges may also obtain these three tests automatically from New York by dialing 015-5, 015-6, and 015-7, respectively, in order to check northbound trunk-circuit transmission.

Exchange Multipling and Group. The rack multipling between the stator points of all group and final selector switches is made with 15-conductor ribbon wire. The 10 points on the preselector switches are multipled in groups of 20 switches each which are wired to 10 GS/TZMs, and some of the latter are shared by several preselector groups. Ten group selectors are multipled in one group. Where the number of outlets exceeds the 10 points on the vertical level of these switches, such as levels 1 or 3 for the Western Union receiving positions or level 2 for the input to the final selectors, a mixing plan arrangement is used and, in some cases, several groups of group selectors share the same outlet.

A Synchronous Switch for Use with the Cathode Ray Oscillograph

D. K. REITAN

MEMBER AIEE

A description of a switch that extends the range of usefulness of the cathode ray oscillograph (CRO) in viewing transient phenomena in electrical circuits by means of a repetitive trace on the CRO.

THE SYNCHRONOUS SWITCH described in this article was developed at the University of Wisconsin. It is a hardy, accurate, mechanically rotating switch that has proved to be completely trouble-free over the past 3 years of use by both graduate and undergraduate students. It should be of especial interest to teachers of electrical engineering concerned with transient circuit analysis. Also, it has found unique use in special power-system transient studies in our A-C Network Calculator Laboratory because of the fact that several switch units can be "electrically geared" together and switched in unison compared to a common 60-cycle reference.

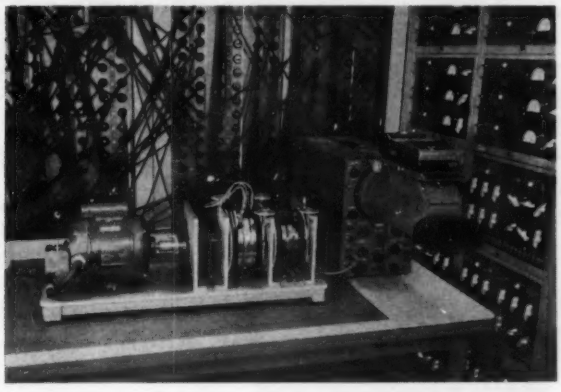


Fig. 1. Over-all view of synchronous switch in use with a-c network calculator.

DESCRIPTION OF THE UNIT

THE OVER-ALL ARRANGEMENT is best known by Figs. 1 and 2. The switching takes place by means of the brushes riding on the revolving drum, as depicted in Fig. 3. The drum is driven through a chain of laminated-phenolic gears by a single-phase synchronous motor. The gear train is so designed that the drum revolves against the 60-cycle supply reference at speeds that are all multiples of 60 cycles, as shown in Table I and Fig. 4. Brief specifications are:

Drive motor. The drive motor is an induction-start reluctance-run synchronous 4-pole single-phase 230/115 volt 60-cps dual-rotation unit. In general, it is connected for 115-volt single rotation. The starting duty is limited to 10 starts per minute. The unit is grounded by a normal 3-wire supply lead.

Gear Train. The gear train provides six drum speeds that are multiples of the 60-cps drive-motor supply and synchronous with it. Table I and Fig. 4 show the drum speed vs gear combinations. Gears *BD* and *EGI* are movable and provide the various speeds. Each gear locks in place by means of a socket-type setscrew. The entire gear train is operated dry; all bearings are ball-type self-sealed and permanently lubricated.

Table I. Drum Speed in Rpm vs Gear Combination.

Gear Combination	A-B	C-D
E–F	900	360
G–H	300	120
I–J	600	240

Electrical. The switching mechanism consists of three metalized carbon brushes (90% copper, 10% carbon) riding on a 6-inch cylindrical drum that connects the

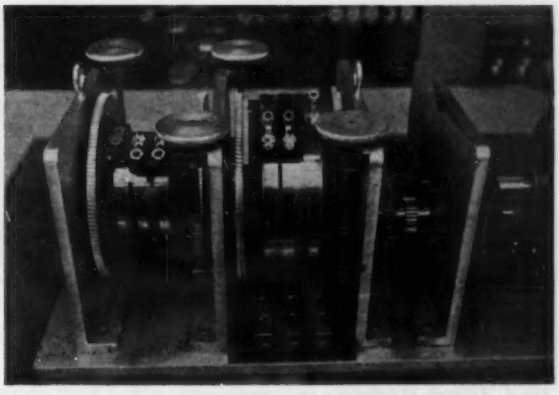


Fig. 2. Close-up of drum and brush mechanism.

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D. K. Reitan is with the University of Wisconsin, Madison, Wis.

middle brush no. 2 alternately to the outside brushes no. 1 and no. 3. Using brushes nos. 1 and 2 the contact or switching angle λ may be controlled accurately

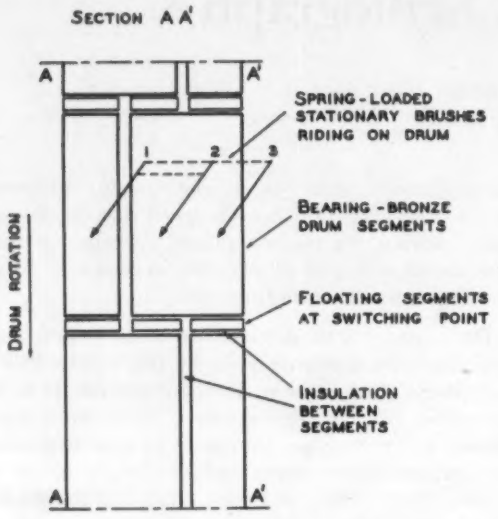


Fig. 3. Planar development of circular drum.

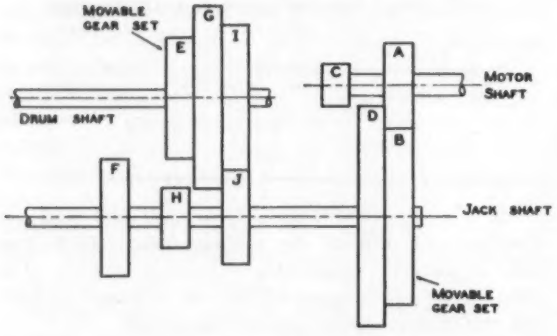


Fig. 4. Schematic of gear train.

through 360° by positioning these two brushes to the appropriate peripheral position. With this combination, brushes 1 and 2 are connected for a half drum-revolution and disconnected for a half drum-revolution. Using brushes 1 and 3 or 2 and 3, one has control of the switching angle λ, the time of connection or "on-time" τ, and the interrupting angle δ. The general peripheral position of the brush mechanism as a whole governs the switching angle, while the "peripheral-spread" between brushes 1 and 3 or 2 and 3 controls the on-time and interrupting angle.

The brushes are positioned by a hand-wheel and worm and ring-gear combination; one control gear for brushes 1 and 2; and a separate control for brush 3. Very fine resolution of setting the angles λ and δ are obtained as shown in Figs. 5, 6, 7, 8, and 9. Synchronizing the CRO is simply and positively effected in the majority of cases by merely using the line-synchronizing provided on most CRO's since the drum speeds are all multiples of 60-cps.

The electrical rating of the drum and brush mechanism is conservative at 500 milliamperes and a segment-to-segment voltage of 100 volts rms (root mean square). Precautions must be observed for capacitor charging, inductor discharging and for inrush exciting currents of certain nonlinear circuitry like iron-core inductors, transformers, etc.

APPLICATION OF THE SYNCHRONOUS SWITCH

ALTHOUGH THE SAME SWITCHING can probably be achieved electronically, it is believed that the undergraduate student gains greater insight into a given experiment if he sees the switching taking place—particularly if he has not reached the status of having completed certain electronic courses.

The design of the nonmetallic gear train, etc., effects minimum operating noise which, although substantial in amount, is completely secondary when it is weighed against the unfailing reliability of the unit and the excellent experimental results that have been continually achieved.

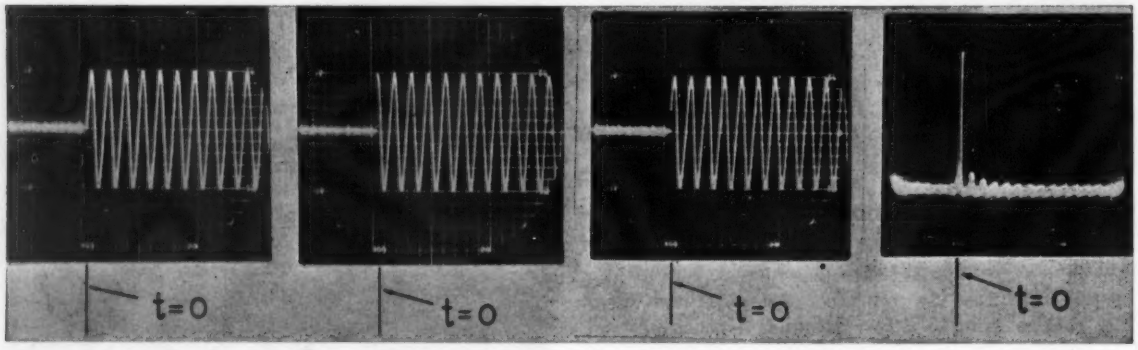


Fig. 5. Example of switching angle performance. (*Left*) $\lambda = 0°$. (*Right*) $\lambda = 90°$.

Fig. 6. Transformer transient. (*Left*) Voltage applied to iron-core transformer; $\lambda \cong 30°$. (*Right*) Resulting exciting current.

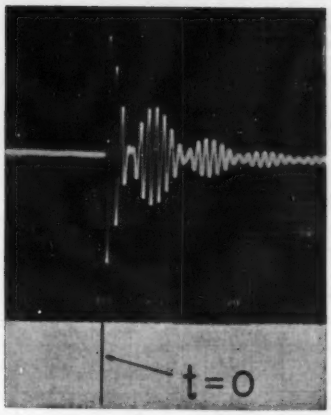
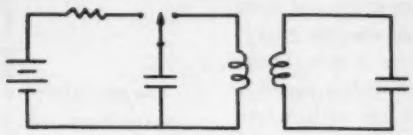
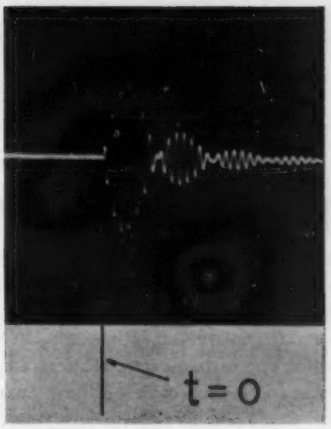


Fig. 7. Tuned coupled RLC circuits. (*Left*) Primary current $i_1 = A \cos \omega t \cos \theta t$ (neglecting R). System energy oscillates between primary and secondary circuits at angular rate θ. When energy U_1 is at a maximum, energy U_2 is at a minimum. (*Right*) Secondary current $i_2 = B \sin \omega t \sin \theta t$ (neglecting R).





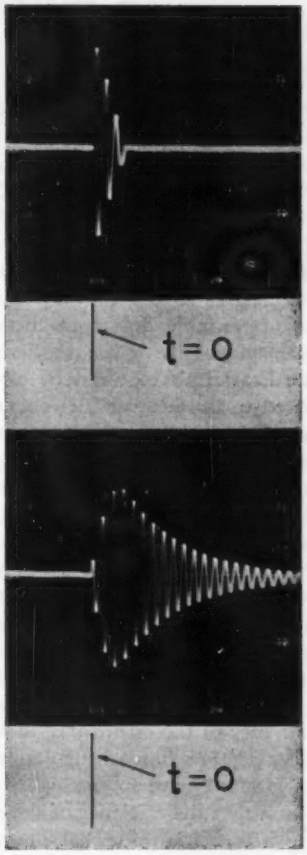


Fig. 8. Tuned coupled RLC circuits. (*Top*) Primary current—with "on-time" τ shortened and the interrupting angle δ moved close to the switching angle λ to the point of the first primary energy minimum; thereby open-circuiting the primary at this instant.

(*Bottom*) Secondary current—with δ set at the first minimum of primary energy, thereby trapping the system energy in the secondary circuit. Trapped energy is thereafter dissipated in a decaying oscillation at an uncoupled frequency.

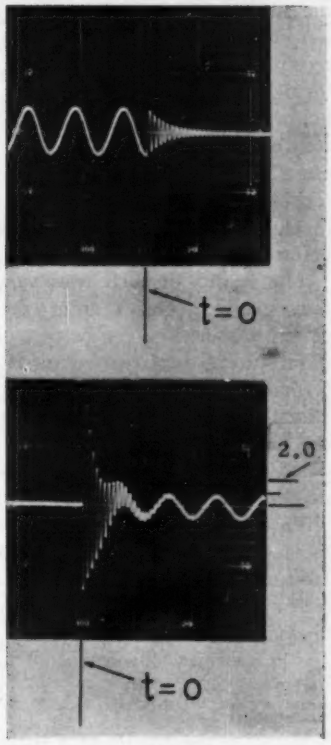


Fig. 9. Transmission line recovery voltage. (*Top*) Fault current interrupted at a current "maximum." $\delta = -90°$.

(*Bottom*) Corresponding recovery voltage at the point of fault. (Not limited to the idealized 2.0 per unit value that arises when $\delta = 0°$)

The following oscillograms exemplify certain practical problems and lucidly show the performance of the switch in terms of λ, δ, and τ. In each of the illustrative, qualitative oscillograms, the drum was operated at 120 rpm (two oscillotraces per second), the CRO sweep speed set at two sweeps per second, and the oscillograms taken by a Land Polaroid camera and an ordinary undergraduate laboratory CRO equivalent to the Du Mont *304A*. The exposure in each case was approximately 40 consecutive repetitions. In the usual classroom and laboratory use of the switch for repetitive transient viewing, the camera is not used; the calibrated oscillotrace is completely and reliably stationary and individual or group observations and measurements can be made unhurriedly. However, the Department's polaroid cameras and inking recorders are often used for permanent repetitive records of a unique problem.

Six of these units have been built at the University of Wisconsin, Madison, Wis. A particular advantage of the double drum arrangement shown in Figs. 1 and 2 is that it enables 12 groups of students to operate simultaneously, each group with its own individual drum and controls.

Residential Heating—Electric vs Gas or Oil

G. S. SMITH
FELLOW AIEE

DURING RECENT YEARS a choice more and more frequently considered is the use of electric energy rather than oil or gas for heating in a new home. About two years ago two houses, one with a modern-type central furnace using oil, the other with a coal furnace converted to use gas, were each equipped with sufficient unit electric heaters to provide the necessary heat. Tests on each of these two houses, both located in the State of Washington were started in January 1956 and run alternately one day on oil, or gas, and the next on electric heat, and careful measurements were made on all fuel used, with weather temperature records obtained from the local weather bureau. Unfortunate circumstances caused tests on the Seattle house with the gas furnace, termed House 2, to be discontinued after a month's run. The tests on the Yakima house with the oil furnace, termed House 1, were continued the next autumn for three months and all through the following winter, but running one week before changing type of fuel.

The results of such tests vary over a considerable range only averages from the complete tests are of real significance. To be of most value in comparing the results of these two houses as well as to arrive at information useful for any type or size of house in any climate, these average results are given in the form of the so-called heating factor, or kwhr per degree day per 1,000 cubic feet of heated space. By converting Btu needed with gas or oil to kwhr units, all values will be given in the same terms. Thus, House 1 gave a heating factor of 0.300 for electric heat and 0.820 for oil, while House 2 gave 0.478 for electric and 1.22 for gas. Using heating factors obtained from several other electrically heated houses in various parts of the country, the average factor for well-constructed houses appears to be a little less than 0.30 kwhr per degree day per 1,000 cubic feet.

To state the results in a little more useful form to the average person, calculations were made for the cost of fuel per unit as found in each house at fuel costs varying over the usual range found in practice. These results are shown in Fig. 1. Thus, to find the cost of electric energy which would be equivalent to oil at 18 cents per gallon when used in House 1, follow the dash line horizontally from the intersection of oil furnace curve and 18 cents per gallon to the electric heat line, and the equivalent cost is 1.26 cents per kwhr. Since House 2 has more heat losses, or occupants of quite different living habits, or both, their cost per heating factor unit at 1.26 kwhr is about 64% higher than for House 1, and their equivalent cost for gas is 1.44 cents per unit.

A multipoint temperature recorder was installed in House 1 to record and compare temperatures at different heights in different rooms. The results indicated no appreciable differences between the two types of fuel, and at living height they were the same. Thus, the heat Btu's required by electric heat can be compared to the heat of fuel burned when using the furnace to give the apparent heating efficiency of each of these furnaces.

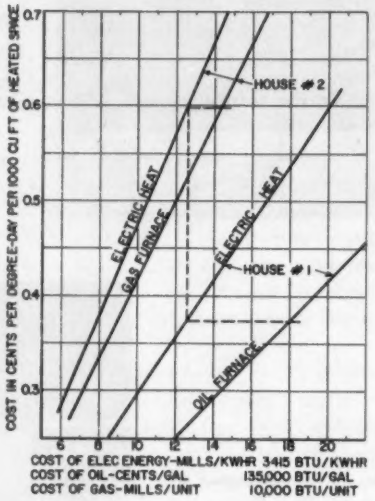


Fig. 1. Cost per heating factor unit for the two houses tested.

An attempt was made to determine any change in this apparent efficiency in very mild weather as compared to normal winter weather. Thus, the ratio of the heating factors for electric and oil heating was found for periods of equal degree days, or again for periods with the same average outside temperatures, as the weather grew colder. A study of these results revealed no change of furnace efficiency with a change in heating demands.

However, from these compiled figures the apparent efficiency of the oil furnace in House 1 averaged about 40%, whereas similar calculations from the month's run on House 2 gave an average of 39%. This seems to indicate that the efficiency of the average furnace in heating a house is somewhat lower than the factory furnace efficiency.

These tests seem to indicate that, at present fuel costs, the average well-constructed and heat-insulated house can, in many parts of the country, be heated electrically at a cost equal and sometimes lower than the more conventional fuels in that locality.

Digest of paper 58-1012, recommended by the AIEE Domestic and Commercial Applications Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Sacramento, Calif., Aug. 19-22, 1958. Published in AIEE *Applications and Industry*, Jan. 1959, pp. 524-29.

G. S. Smith is with the University of Washington, Seattle, Wash.

Analysis and Evaluation of Noise in Household Refrigerators

E. A. BAILLIF

J. P. LAUGHLIN
ASSOCIATE MEMBER AIEE

In the second part of a two-part article, the emphasis is on noise testing, first of the compressor and then of the refrigerator as a whole. Avenues of approach in designing for noise reduction are also described.

Part II

COMPRESSOR NOISE TESTING

THE QUIETNESS of the refrigerator is the end result of noise reduction at many points in the system. Noise reduction measures must be such as to attack the most troublesome element first and then proceed methodically to others until a satisfactory design level has been achieved. Because the major source of all noise in the refrigerator stems from the compressor, this is the element which has received the most attention throughout the years as it has been sought to keep the refrigerator noise level unobtrusive.

From a design standpoint it is well to keep in mind potential noise-producing criteria; for example, resonant frequencies of machine components. These can seldom be calculated because of the complexity of the shape of the component and/or the manner in which it is attached into the system. However, on a sample part, the resonant frequencies can be determined by either striking it or driving it electromagnetically while comparing the emitted tones with a variable audio-frequency sound source. Resonant components are bothersome because they have families of resonant frequencies, i.e. multiple harmonics, any one or several of which may be excited into forced vibration either by repetitive impacts or by oscillatory-type exciting forces near resonance.

Speaking from the standpoint of an acceptable designed noise level in the compressor, there are a great multitude of possible production deviations which can make for an unacceptable noise level. These could include metallic impact of moving parts, hydraulic or gas pressure disturbances, defective bearings, loose or mismatched parts, excessive clearances, burrs, foreign matter, misalignments, and magnetic disturbances. With these possibilities, which also influence performance, it is easy to see why manufacturing sets high standards on the production of parts for compressors. Long experience and constant surveillance by quality control allow but few compressors to reach final compressor assembly with adverse noise. And it is at this point that a noise check is made to determine whether any deviations have slipped by. This is the so-called "free space" test, wherein a compressor is run under dynamic operating conditions within a noise test cell while controlled by a separate refrigeration system. The "free space" noise test takes two forms as shown in Figs. 9 and 10. Fig. 9 shows the compressor arranged for noise test on a spring isolator in the sound room of Figs. 1 and 2. This engineering test enables analysis of new compressor designs, along with comparison with statistical averages on compressor modifications, and further enables the spot checking of production compressor noise. Fig. 10 shows the quality control noise test on compressors and is used as a gauge of production noise.

The test cell shown in Fig. 10 was designed by the engineering department to produce a usable ambient sound level in a high industrial ambient noise level. Fig. 11 shows the results of this attenuation of extraneous noise, which enables comparison at the significant compressor noise frequencies. Compressors whose noise level exceed a standard are examined and the deviations found referred back to production to enable rapid correction of the production process responsible for the noise deviation.

As a follow-up on this "free space" test the entire refrigeration unit is run through a sound labyrinth while energized, to enable an aural check to be made on the compressor noise. It is, of course, necessary for the operator at this point to be trained to disassociate extraneous noise originating from the moving conveyor, component rattles on the hanging rack, etc. Units which do not pass this 100% test are again analyzed for the noise producing deviations. This double noise check can be seen to prevent the great majority of noisy compressors from even reaching the final refrigerator assembly.

Having now traced the compressor through production, it is well to retrogress to the design standpoint for some further look at the methods of analysis of noise, and some examples of the results obtained.

Engineering noise tests based on theory, assumptions, and the actual insertion of known defects into the compressor have been made to build up a backlog of valuable comparative data. Thus, when a test is run with results as shown in Figs. 12 and 13 (which show

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Dr. E. A. Baillif and J. P. Laughlin are with the Whirlpool Corporation, Evansville, Ind.

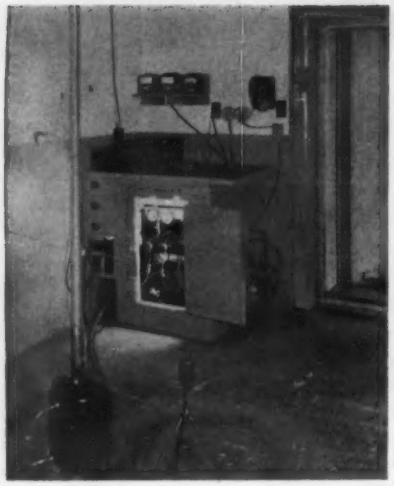


Fig. 9 (*left*). Compressor on test.

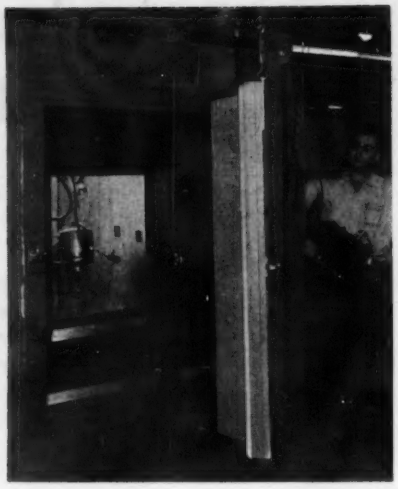


Fig. 10 (*right*). Quality control noise test cell for compressors.

the *A* network and octave band readings in decibels, and the computed sone rating, by both the Beranek and Stevens methods, for an experimental compressor tested under dynamic operation on the engineering free space setup), it is possible to compare this data with the reference data from prior tests. By proper interpretations of this data, it is possible to determine whether this compressor will perform satisfactorily from the standpoint of noise when applied to a refrigerator. It should be noted that proper interpretation is important, since differences in the test setup microphone locations, room characteristics, and barrier effect and sound reduction measures used on the refrigerator cabinet reduce or, in some cases, amplify certain frequency bands when the compressor is applied to the cabinet.

To pinpoint the noise spectrum further, a discrete frequency noise spectrum is also made using the sound level meter, sound analyzer, and sound apparatus recorder. The discrete or individual frequencies can be identified by this method and a more detailed analysis thus facilitated.

The panoramic sonic analyzer should be mentioned again at this point inasmuch as this instrument will display a visual discrete frequency spectrum once each second. This visual portrayal of the noise spectrum enables rapid comparisons to be made by changes in the operating conditions of the compressor, for example, it may indicate that at certain voltages, i.e. speeds, or at different combinations of suction and discharge pressures, resonant conditions occur. A permanent record at any point can be obtained by photographing the visual trace. This same information possibly could be obtained by the slower graphic recorder and discrete frequency analyzer, but in a much more laborious manner and with the problems of maintaining the exact same conditions for the necessary time durations of this slower test method.

A still further step can be made in the analysis by recording on tape the effects of either component or dynamic operating changes and then playing back short connected excerpts of these tapes for aural judgments. This is particularly helpful when delays are encountered in experimental changes, or it is desired to compare experimental designs vs production on an aural "before" and "after" basis.

So far, only the airborne transducer or microphone method of analysis has been discussed. However, there are other transducers which also will contribute valuable information on noise analysis. One such transducer is the vibration pickup. This method of analysis runs a close second to the microphone airborne analysis, because vibration is indicative of airborne noise. It should be mentioned that all the sound-measuring instruments previously discussed are compatible with the vibration pickup, the only major physical change being

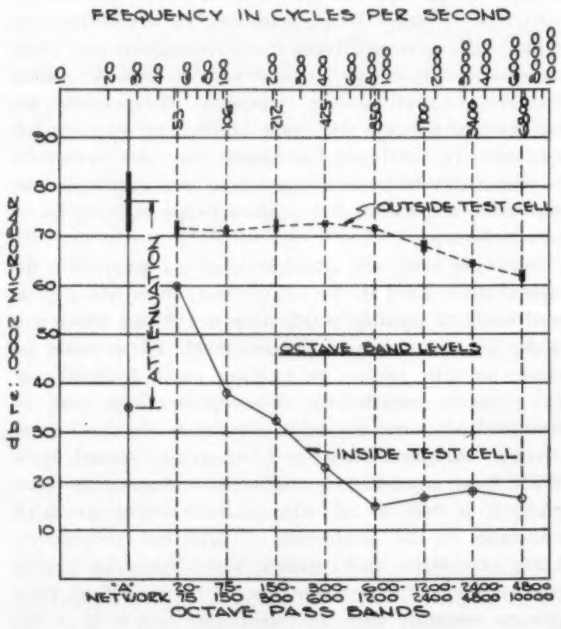


Fig. 11. Attenuation chart for quality control noise test cell.

to replace the microphone by the vibration pickup as the SLM input. The pickup used in this case is the General Radio type *759-P35* inertia-operated crystal device. However, special applications requiring negligible pickup mass are best met by adopting guitar pickups or high-fidelity phonograph pickups to the task at hand. Use of the latter-type pickup in the torsional, vertical, and horizontal planes of vibration of the compressor can be helpful in the determination of component unbalances and/or pressure unbalances in the compressor. Again, compressor housing vibration patterns can be traced out with a low mass pickup placed successively at multiple grid positions on the housing.

Another particularly valuable aid to diagnosing compressor noise and the resultant unit noise is the pressure transducer. Applied to the gas stream of the compressor, this transducer can show the effects of internal component changes on the pressure wave and the "before" and "after" effects of mufflers or pressure pulsation snubbers. Again, this transducer is compatible to the sound instruments discussed and would physically replace the microphone as the SLM input.

The analytical tests have by no means been exhausted at this point, as two further examples will show. One interesting method of analysis is isolating one disturbance by removing its effect from the near field of the compressor noise. An example of this is shown in Fig. 14, in which an external drive compressor test stand is shown. This test apparatus is to permit the compressor to be driven either by its integral motor, or by an external motor coupled through a long shaft to the compressor. This test, when weighed in terms of the effect of the shaft bearing noise, allows isolation of the magnetic noise of the compressor motor.

One more example of a special test method would be the use of magnetic pickups on a rotating part of the compressor in combination with a capacitive pickup formed from the discharge valve of the compressor, to investigate the effect of compressor valve action on the noise spectrum.

It is apparent by this time that the basic instruments are really only the starting point in analyzing noise and can be supplemented by special apparatus, limited only by the imagination of the engineer, to attack any phase of the compressor as a noise generator.

REFRIGERATOR TESTING

THE ACTUAL TESTING ARRANGEMENT is shown in Fig. 15, which is a view of the refrigerator on test situated in place in the test room. The refrigerator is allowed to run, usually outside the test rooms, for a period of time in order to reach equilibrium conditions, before any sound readings are taken. This is necessary because the noise produced by a refrigerator pulling down is not quite typical of normal operation, although, actually a fairly good idea of the noise level can be had during pulldown if a quick check is necessary and no pulldown time is available.

The balance of the test setup is comprised of the microphone and the measuring instruments. The microphone is situated at a height of 51½ inches from the floor, which is the approximate ear height of the average seated person, and at three positions around the refrigerator.

Markings on the floor serve to facilitate placing of the microphone. The instruments for reading and recording, described earlier, are located for one of the

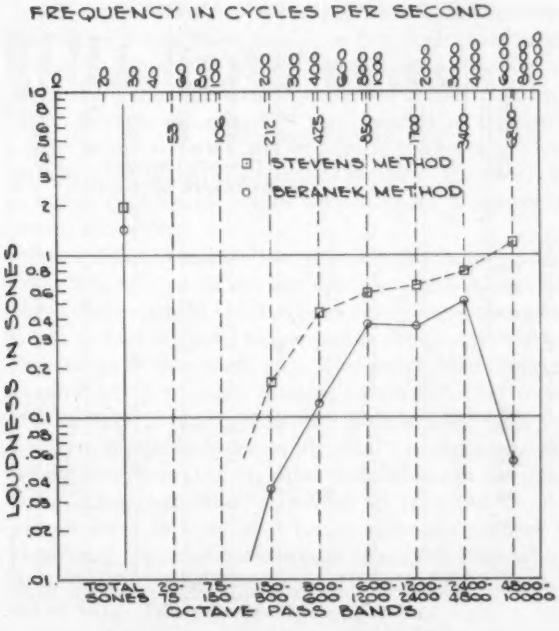


Fig. 12. Compressor noise expressed in sones.

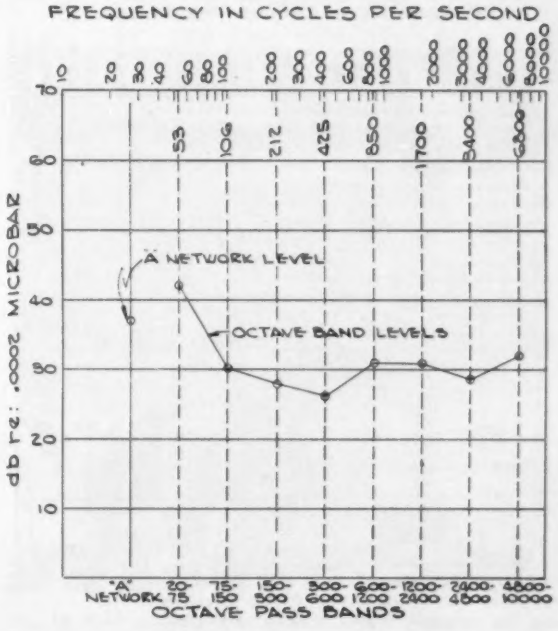
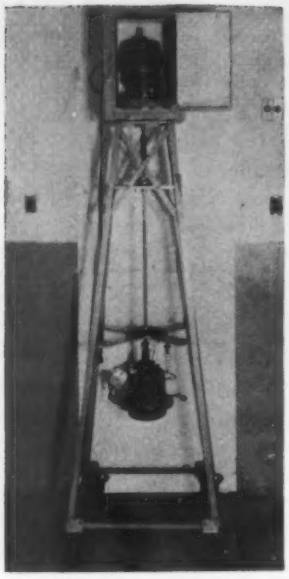


Fig. 13. Compressor noise expressed in db.



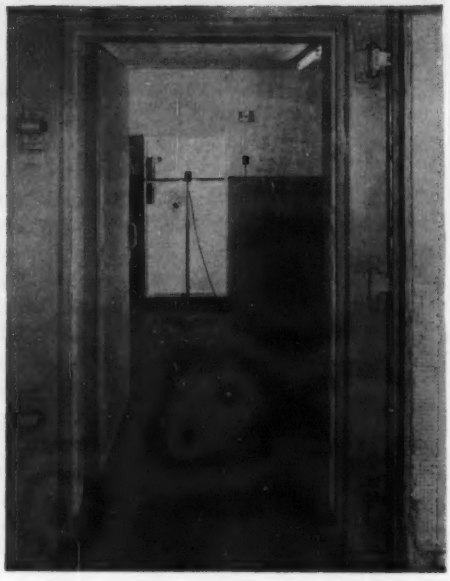


Fig. 14. (*left*). External drive compressor test stand. Fig. 15 (*right*). View of refrigerator on test in sound room.

sound rooms in a small closet in the corner of the sound room, and for the other outside the sound room on a panel. These arrangements were shown in Figs. 2 and 4, respectively.

Data from these tests are obtained on the various instruments as described here. First the *A*, *B*, and *C* network readings using the SLM are obtained. Room level corrections, if necessary, are made on these readings. The three corrected *A* network readings are then averaged arithmetically, and this figure is recorded. It should be mentioned that for years this is the figure that has been used in describing noise level and, as mentioned before, as long as we are comparing one refrigerator with another and as long as their frequency distributions are similar, this average decibel reading corresponds fairly well to a loudness rating in sones. Sone readings, obtained as described previously, are also used now, but so far it has been impractical to disregard the decibel readings completely because of the long history of knowledge of them that has been built

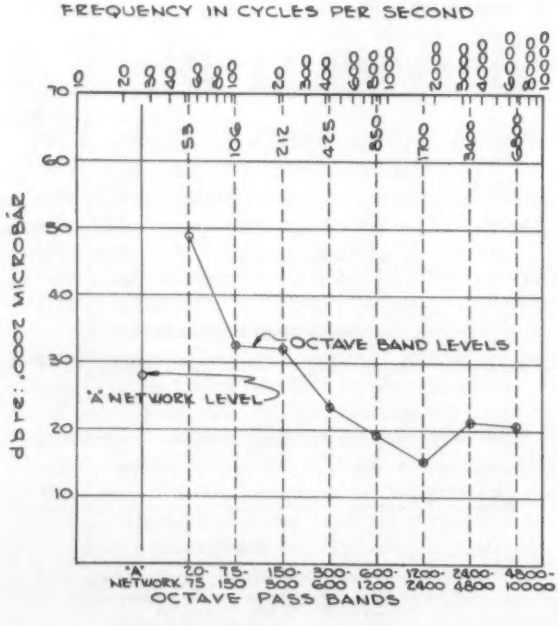


Fig. 16. Refrigerator noise expressed in db.

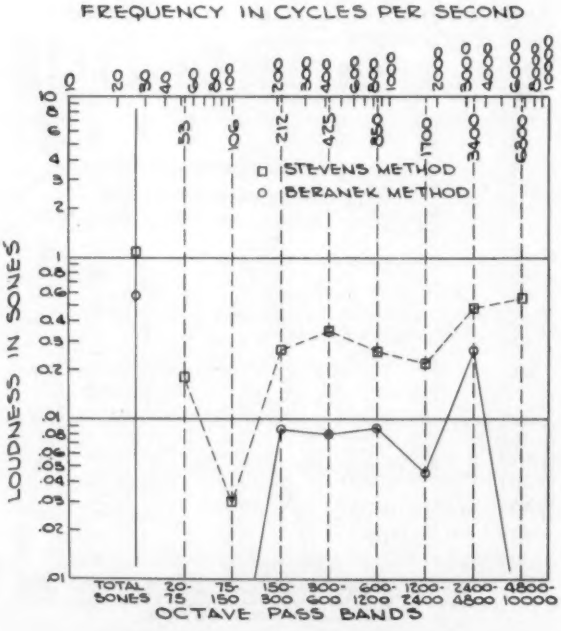


Fig. 17. Refrigerator noise expressed in sones.

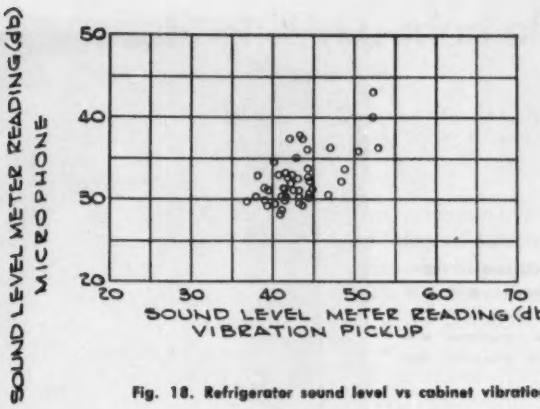


Fig. 18. Refrigerator sound level vs cabinet vibration.

up by people around the plant who have little other contact with the process of noise testing. In general, however, this is not too misleading, unless one tries to compare a refrigerator and an air conditioner, for example, on this basis, in which case the comparative decibel readings become very misleading because of the difference in frequency spectrum between the two.

The output on the SLM is then fed into an octave band analyzer for one or more of the three microphone positions, and the decibel level in each of the bands is recorded and the sone value computed. A typical set of data for the SLM, octave band analyzer, and the evaluated sone value is shown in Figs. 16 and 17.

The output from the SLM can also be fed to the discrete-frequency sound analyzer and recorder. This is usually done for one position of the microphone. There is much to be gained from the results of such a record, inasmuch as one can examine discrete frequencies and predict with much greater accuracy what is causing any trouble spots which may exist. It is somewhat time consuming to obtain these results, in that each chart takes about 5 minutes to obtain by the time the pen is aligned for starting, etc. However, the record obtained is permanent, accurate, and very possibly of immense value in investigating the degree of improvement resulting from design changes and the like. Therefore, it is usual practice to obtain such a chart whenever a sound test is run.

Of a different nature but also of value is the sound recording on tape of the test machine. This is done so that a design may be checked before and after a change is made and for purposes of comparing competitive refrigerators and other such uses. The value here, besides obtaining a permanent historical record, is that these tapes may be analyzed at a future date, although the inaccuracy of the recorder, while small, is superimposed on the inaccuracies of the other instruments in the final noise evaluation. Also, a number of tests can be arranged on a tape to give management and others a thumbnail sketch of noise results in audible form without having to move several machines in, one after the other, which is a time-consuming process.

One other device sometimes used is the panoramic analyzer referred to earlier. The noise spectrum trace is repeated every second so that changes can be investigated as they happen, or are imposed. This provides a much more flexible means for examining transients and other short-duration irregularities. Such changes as the effect of tube clamps and the like can be evaluated instantaneously with this device, and, in addition, a permanent photographic record can be kept if desired.

Something should be said regarding the quality control of finished refrigerators insofar as noise is concerned. This is a problem with all manufacturers of large machines or appliances. The method that has enjoyed the most success is to quality control the parts, 100% noise check the finished unit, as described earlier, and then have a 100% check of the finished refrigerator for assembly defects. This gives satisfactory control and maintains a high level of quality.

It is also possible to run the finished refrigerators on the assembly line through a noise room, but the openings necessary to allow the line to pass through the noise room and the attendant conveyor noise makes this all but impractical. Also the problem can be dealt with on a batch basis, taking several finished machines at a time into a large noise room or several small ones. This is difficult to do on any but a sample basis. It should be mentioned that a percentage of the total production is routed through a sound test room as an additional quality control measure. However, this is not done on the production line, but rather on a sample basis from the warehouse. This method has the advantage of being a test exactly comparable to what is met with in the field and includes the processes of crating and uncrating as, of course, would be the case in the store or customer's house.

An interesting possibility was closely examined several years ago. The thought was that if a vibration

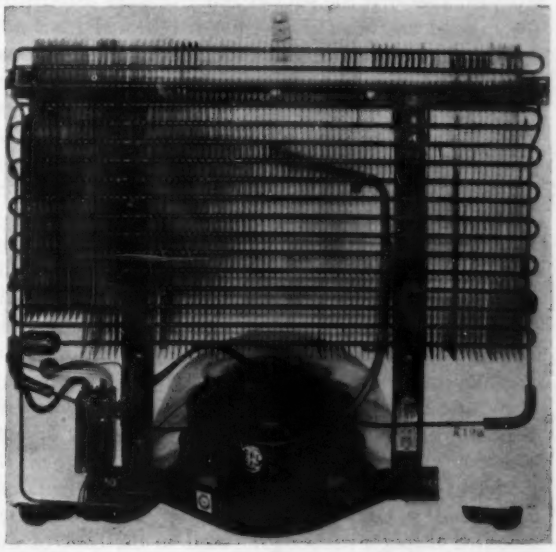
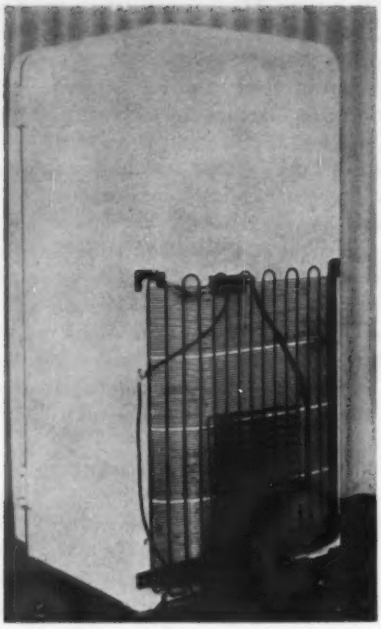


Fig. 19. View of refrigerator, showing integral condenser and precooler.



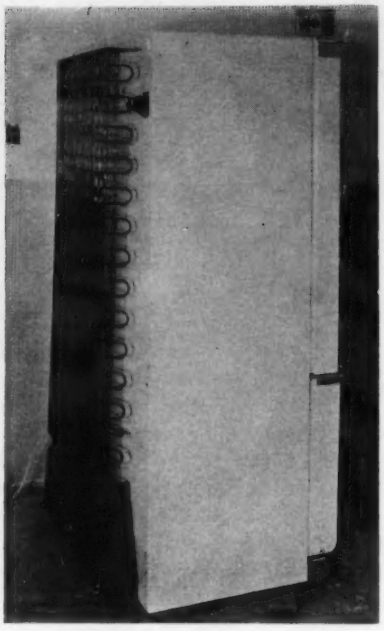


Fig. 20 (left). View of refrigerator, showing separation of precooler and condenser. Fig. 21 (right). View of refrigerator, showing covered compressor and flexible mounted integral precooler and condenser.

pickup, which could be used on the assembly line, could be applied by some means to a "magic spot" on the cabinet or unit, and so located to give a reading which could be correlated to sound level, a very valuable means of controlling noise would be available. Several types of pickups were tried and many different locations examined, but to little avail. The correlation was present in some of the very noisy products which would have been singled out anyway, but did not exist to a large enough degree to be useful. In fact, over most of the range there was no correlation at all, as shown in Fig. 18. The failure of this sort of test probably stems from the fact that the stresses and vibration patterns in the cabinet are not closely enough repeated from one cabinet to the next to give a valid comparison. Even the vibration of the unit itself suffers from this lack of exact similarity from one to the next. However, the fact remains that if some such device could be made to do the job, it would be a very valuable tool.

NOISE REDUCTION THROUGH DESIGN

THERE IS ALWAYS the problem of cost when noise reduction is desired. Many types of acoustical insulation and absorbers are possible, but the effect on the over-all cost is prohibitive in many cases simply because the customer wants the final product quiet but generally not at a high premium in cost. This paradox of attempting to get something for nothing leads the noise engineer to work diligently in the area of noise control by design. The examples presented here illustrate this.

Several years ago, one of the models of refrigerators made had a combination precooler and condenser mounted through rubber grommets to the back of the refrigerator. This unit construction is shown in Fig. 19. This over-all noise level was quite acceptable but there was a definite tendency toward a "beat." This was caused by a vibration frequency of the motor beating with a gas pulsation frequency in the precooler. These were only slightly different because of the slip of the motor, as is the case in any such motor that does not run at synchronous speed. The compressed gas went from the precooler back into the compressor housing before passing into the condenser. Therefore, if the precooler could be separated from the condenser and mounted on the compressor, which was itself isolated from the cabinet, this beat could be eliminated. This was done and is illustrated in Fig. 20. The success of this type of design is self-evident.

Another example occurred in 1956 when it was decided to produce on some models a very low noise level. One very effective procedure, especially in the higher frequency ranges, is to baffle the noise emitted by a machine. For this purpose, a cover was designed which very effectively lowered the noise level. In order to maintain a suitable unitized condensing unit, it was also decided to recombine the condenser and precooler and provide for vibration isolation of the whole condensing unit from the cabinet. This arrangement is shown in Fig. 21. The side results in this case were that the defrost evaporation from the pan under the refrigerator was increased as much as 40% and also that the compressor tended to run cooler. In both cases, the improvement was caused by the flue effect provided by the combination of the evaporating pan and the compressor cover.

Many other examples of noise reduction can be seen in almost every machine or appliance produced today. It is an immense field—one that is enjoying ever-increasing concentration and one on which even greater demands will undoubtedly continue to be placed.

Ground-Fault Protection of Unit-Connected Generators

M. N. RAJK
MEMBER AIEE

THE INCREASING SIZE of turbine–generators on large power supply systems means that a sudden loss of a unit tends to endanger the continuity of power supply over large areas. Because of this, some operating companies prefer to sound an alarm upon the detection of generator ground faults which in themselves do not cause immediate disability of the generator. The unit is then taken out of service at the first opportunity.

A study has been made to investigate the danger of serious damage to the generator if it is in service for some time after a ground fault occurs, and to determine the best ground-fault protection in view of such a service. The study has been restricted to large unit-connected generators.

The main risk of operation after a ground fault has occurred is the possibility of a double ground fault because of the increased voltage to ground on the unfaulted phases. The assessment of this risk should have first consideration when decision is made as to whether the faulted generator is to be tripped immediately or kept temporarily in service. This risk is essentially the same with any type of high-impedance neutral-grounding method.

The study has been extended to three usual neutral-grounding methods:

1. Potential-transformer grounding, which in its effects is substantially equivalent to ungrounded neutral.
2. Resistor grounding, with the resistance value equal to the capacitive impedance to ground of the generator windings and the connected system at generator voltage. The effect is the same whether the resistor is connected directly between generator neutral and ground or in the secondary winding of a distribution transformer.
3. Ground fault neutralizer grounding with a resistive component of 5% in the tuned circuit. The assumption of this resistance value gives results as encountered in practical cases.

It is found that of the three grounding methods, the ground-fault neutralizer gives the best protection to the generator. The current through the fault is reduced to a small fraction of the fault current with other neutral grounding methods, because the capacitive component caused by the generator and system capacities to ground are almost completely compensated by the inductive current through the neutralizer coil. Consequently, the heat development in the fault and the danger of iron burning become smaller.

Digest of paper 58-900, recommended by the AIEE Protective Devices Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Published in AIEE *Power Apparatus and Systems*, Dec. 1958, pp. 1082-94.

M. N. Rajk is with Sanderson & Porter Engineers, New York, N. Y.

This heat reduction is of little significance if the current in the ground fault flows directly from metal to metal or through well-conducting carbonized material. The resistance in the fault is so small as to cause very little heat development in any case. But the heat is not negligible if the fault current forms an arc.

The heat development in the ground fault arc of a neutralizer protected generator is expected to be smaller in a ratio between 2:1 and 8:1 than in the fault of a resistor-protected generator.

From R. Pohl's experiments,[1] it is to be concluded that some degree of iron burning is to be expected, if the arc current has a value of 5 amperes. Therefore, it is advantageous to reduce this current to a much smaller value.

It is to be expected that the ground-fault neutralizer would do more than reduce the current; it would extinguish the arc at first current zero. Applying other grounding methods than the ground-fault neutralizer, the extinction or duration of the arc is uncertain.

The method of neutral grounding has a considerable influence on the detection of a ground fault. H. R. Tomlinson[2] pointed out that a ground-fault neutralizer increases the ground-fault relaying sensitivity to a high degree. The usual method of ground-fault relaying is to make the relay response depend on the voltage between ground and generator neutral. A decreasing insulation resistance in one phase means a voltage displacement between ground and neutral. For equal fault resistance, the neutral displacement is much larger with neutralizer grounding than with other grounding methods and, consequently, the relaying is much more sensitive.

In addition to the relaying sensitivity, the heat developed in the fault resistance is of importance. This heat development in the resistance of the deteriorating insulation is much smaller if a ground-fault neutralizer is used, and will not contribute appreciably to further damage of the insulation.

The usually applied ground-fault relays have a better than 10% sensitivity. This means that they will respond before the voltage displacement of the neutral reaches 10% of the neutral-to-phase voltage.

REFERENCES

1. Iron Burns by Electric Arcs of Low Current Value, R. Pohl. *AEG Mitteilungen*, Berlin-Grunewald, Germany, Jan. 1930, pp. 36-41.

2. Ground-Fault Neutralizer Grounding of Unit-Connected Gererators, H. R. Tomlinson. AIEE *Transactions*, vol. 72, pt. III, Oct. 1953, pp. 953-60.

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INSTITUTE ACTIVITIES

District Meeting Discusses "New Horizons in Power and Industry"

THE MEETING of the AIEE Empire District at the Hotel Syracuse, April 29-May 1, in Syracuse, N.Y., had as its theme, "New Horizons in Power and Industry." Approximately 440 members and guests who attended the meeting were unanimous in their praise for the technical and social programs.

The general session, presided over by Paul Kartluke, the general chairman of the meeting, opened with an address of welcome from Dr. Benjamin Sauer, the representative of Syracuse's Mayor Henninger. This was followed by an address by AIEE Vice-President L. C. Holmes.

Mr. Holmes gave a brief history of the Empire District with its 2,700 members and its student branches, and concluded with the fact that it had reached more than 96% of its quota for the new Engineering Center. He then introduced AIEE President L. F. Hickernell, who described the Institute's organization and various activities. (See page 672 for Part I of this talk.)

The principal speaker at the general luncheon, which followed the general session, was E. J. Machold, president of the Niagara Mohawk Power Corp., whose subject was "Responsibilities of a Utility in Our New Horizons." After describing his company's two new 210,000-kw units at Huntley Station in Buffalo, N.Y., and two others of the same capacity at Dunkirk station, Mr. Machold told that Niagara Mohawk has contracted to take 115,000 kw of firm power from the St. Lawrence project and all other power not required by the Authority's other customers. He discussed the engineering problems which had to be solved and described his company's new $3.5 million Porter switching station near Utica and the two 230,000-volt circuits extending 55 miles from that station to the Authority's delivery point near Taylorville, N.Y.

Turning to atomic power, Mr. Machold said his company was engaged in two projects: the Atomic Power Development Associates and the new High Temperature Reactor Development Associates, Inc. It will be through participation in these projects that Niagara Mohawk will be ready to supplement its other sources of power with energy generated from atomic plants when they become economical and competitive.

The smoker, which was held on Wednesday, and the dinner dance on the next evening, were enjoyed greatly by the large number who attended. The ladies activities included a dinner at the University Club, a tour of the Onondaga Pottery Works, and a card party at the Drumlins Golf Club.

Student Prize Paper Competition

Nine papers were presented by students from seven colleges in this District competition, in which the papers themselves as well as their presentation are taken into consideration for the prizes.

D. M. Davies and R. L. Allen, both of Clarkson College of Technology, won the first prize with their paper, "A Transistorized Pulse Monitor." R. J. Lutz of Cornell University, won the second prize with his paper, "The Measurement of Minimum Perceptible Changes in Sound Frequency."

The judges declared a tie for the third prize: Christopher Smith of Union College for his paper "Cryogenics," and W. A. Hessinger of the University of Buffalo for his paper "The Voltage-Variable Capacitor."

At a meeting of the Student Branch counselors, E. V. Kosso of Syracuse University was elected chairman of the Student Activities Committee for the coming year.

Technical Sessions

Some 16 technical sessions were held on the 2½ days of the meeting, covering several phases of the power industry, communications, basic sciences, and education.

In a session on industrial power systems, W. A. Weddendorf, Mutual Boiler and Machinery Insurance Co., presented, "Education and Maintenance in the Operation of Industrial Power Systems." The battle of securing a reliable power system is only partially won with the purchase of adequate apparatus. Much money in losses from physical damage and the associated interruption to production are incurred annually from accidental damage because of maintenance deficiencies and the apathy of workers.

One of the outstanding sessions was that devoted to electrical engineering education, in which four professors gave their ideas about the training a man needs to fit him for this field.

Prof. L. B. Winsor, Rensselaer Polytechnic Institute, stated that schools should train young engineers to cope with new work; in other words, they should be prepared to meet the needs of 25 years from when they are in college. Prof. Winsor said that fundamental engineering should be given the students in college and that a specialized professional training should be given him later by the company for which he works after graduation.

Prof. G. W. Reed, Clarkson College of Technology, gave a resume of the studies of curricula from their start in 1931. After World War II, the American Society for Engineering Education studied curricula as to what was needed in education, and in 1955 a report was made showing what scientific studies would fit a man for any engineering work.

Prof. H. W. Bibber, Union College, said that economics were an important factor and too little considered in engineering

Tisdell Studio

STUDENT PAPER CONTEST WINNERS at the Empire District Meeting of AIEE were *(left to right)*: R. J. Lutz, Cornell University, second prize; W. A. Hessinger, University of Buffalo, who tied for third prize; Prof. Eugene Kosso, Syracuse University; Christopher Smith, Union College, tied for third place; D. M. Davies and R. L. Allen, both of Clarkson Institute of Technology, first prize winners.

studies at college, and to a great extent in managerial post-graduate schools.

Prof. W. H. Erickson, Cornell University, stated that there had been an upgrading of curricula in the last few years, but not an up-grading of students. He asked, "Are students afraid of engineering and, therefore, take arts and sciences courses?" Attrition among freshmen is on the increase, as there seems to be a tendency toward their taking easier courses. He maintained that this frame of mind was given to students while they were in high school and that they were not being taught to think enough for themselves.

In a session devoted to communications, four papers were presented which described the different planning phases for a controlled switching point in central New York State in the nation-wide telephone dialing network by engineers of the New York Telephone Co. These dealt with the fundamental planning, the trunking facilities, and the switching facilities. The fourth paper described the routing of a call to a distant point and then a demonstration with a call to San Francisco, Calif., from the speaker's platform, which was completed in 28 seconds.

Tisdell Studio

AIEE President L. F. Hickernell talks with E. J. Machold, president of the Niagara Mohawk Power Corp., at the Empire District Meeting of the Institute, held April 29-May 1, 1959, in Syracuse, N. Y. Mr. Machold was principal speaker at the general luncheon.

Electrical Engineers Saluted on Celebration of 75th Anniversary

SOME 500 representatives of industry, colleges, engineering societies, and the press in the New York City area gathered at a luncheon on May 13 in the Hotel Astor to hear W. P. Marshall, president of Western Union, describe some of the new electrical wonders that are now being developed and to salute the AIEE. The occassion was the commemoration of the Institute's founding meeting which took place 75 years ago, on May 13, 1884. The luncheon was one of many such affairs which will be held throughout the country by the Institute's 112 Sections to mark the Diamond Jubilee Year.

AIEE, whose 1884 roster listed 71 members, among them such notables as Thomas A. Edison and Alexander Graham Bell, is now a world-wide organization with a membership exceeding 54,000. The original organizational meeting took place in New York City at the offices of the American Society of Civil Engineers on East 23rd Street. Norvin Green, president of the Western Union Telegraph Co. was elected the first president of AIEE.

The 75th Anniversary celebration was held under the auspices of the New York Founders Day Committee, A. J. Cooper of Short Hills, N. J., chairman.

L. F. Hickernell, president of AIEE, and vice-president–engineering, Anaconda Wire & Cable Company, traced the history of the Institute, and discussed its plans for the future under the anniversary slogan—"75 Years—A Prologue to the Future." W. T. Rea, chairman of the New York Section, acted as master of ceremonies.

On the dais and in the audience were executives of most of the utilities and electrical manufacturing concerns in the Greater New York area. Also present were representatives of AIEE's sister engineering societies, the American Society of Civil Engineers, the American Institute of Chemical Engineers, and the American Society of Mechanical Engineers. Colleges and universities represented were the City College of the College of the City of New York, Columbia University, Cooper Union, Manhattan College, Newark College of Engineering, New York University, Polytechnic Institute of Brooklyn, Pratt Institute, and Rutgers University. About 65 members of the press from New York and New Jersey dailies and technical and trade publications were present.

Ross Photos

Ross Photos

ON WEDNESDAY, MAY 13, 1959, the Hotel Astor was the scene of the 75th Anniversary Luncheon of the AIEE, commemorating the Institute's founding meeting which took place on May 13, 1884. *Above, left:* Among those helping to celebrate the occasion were: (left to right) W. T. Rea, chairman of the New York Section, who acted as master of ceremonies for the program; W. P. Marshall, president of The Western Union Telegraph Company; A. J. Cooper, chairman of the New York Founders Day Committee; and L. F. Hickernell, president of the Institute. *Above, right:* S. M. Osthagen (*left*), AIEE vice-president for the North Eastern District, and J. R. Kerner (*right*), AIEE vice-president for the Metropolitan District, display the original "call" to form the Institute signed by 71 members in 1884.

East Central District Meeting and Rubber and Plastics Conference

OVER 550 AIEE members and guests were present at the East Central District Meeting, held in conjunction with the Rubber and Plastics Conference at the Sheraton Hotel, Akron, Ohio, April 22-24, 1959. The general theme of the meeting was "Electricity—Major Tool of Industry."

Technical sessions were held on high-voltage cables, computers, rotating machinery, industrial heating, static components, automation, and a variety of other subjects of interest to electrical engineers. In addition, six sessions of particular interest to those in the rubber and plastics industry were arranged by the Rubber and Plastics Subcommittee.

Inspection trips were made to the Ohio Brass Company, the Chrysler Corporation's stamping plant, the Ohio Edison Company 345-kv test line, the B. F. Goodrich Research Center, the Firestone Research Laboratories, and the Columbia-Southern Chemical Corporation.

Among the social events were an "early bird" reception held on April 21, two ladies' luncheons, and a tour of the Stan Hywet Hall and Gardens. A banquet for members, wives, and guests was held on April 23. The principal speaker was D. C. Romick, head of the Astronautics Section of the weapons system department of the Goodyear Aircraft Corporation, who discussed the development of space flight and its impact on the future.

General Session

W. H. Sammis, meeting chairman, opened the general session, held Wednesday afternoon, and introduced Akron's mayor, Leo Berg, who gave a welcoming speech to the assembly. A brief address was then presented by E. L. Smith, chairman of the Akron Section and of the Rubber and Plastics Subcommittee. R. J. Feeney, vice-chairman of the meeting, introduced the various committee chairmen. W. H. Chase, vice-president, AIEE District No. 11, described the East Central District as one of the most active and vigorous, and commended its members on a job well done. AIEE President Hickernell commented briefly on "The Institute and Its Operations." His address, in expanded form, is being published in three parts in *Electrical Engineering* (June–August 1959).

The keynote address was presented by C. H. Linder, AIEE treasurer, and vice-president, engineering services, General Electric Company. He pointed out some of the "dimensions" which are exerting the most significant influences on our lives—such as increase in longevity, developments in transportation and communication, increases in demand, and a greatly accelerated technological pace. He then went on to describe the responsibility of engineers and scientists, as well as of business, in meeting the needs of our complex technological society. He also stressed the fact that because other nations are also growing at a tremendous rate, the United States must constantly make adjustment to its ever-changing position in the over-all picture.

Student Paper Competition

Winners of the District No. 11 Student Prize Paper Competition held during the meeting were: first prize—R. W. Hall, University of Toledo, "Design of Apparatus To Remotely Handle Radioactive Material"; second prize—M. D. VerSchure, University of Michigan, "Parametric Amplifiers"; third prize—R. P. Whitman, Case Institute of Technology, "The Principles of the Phase Switching Interferometer."

Other papers presented were as follows: "Magneto-Hydrodynamics," by Arno Nice, Fenn College; "Electroluminescence," by K. H. Thompson, Akron University; "A 5-Megacycle Square Wave Generator," by J. M. Walter, University of Cincinnati; and "An Automotive Voltage Regulator," by D. R. Hicke, University of Detroit.

AT THE GENERAL SESSION of the AIEE East Central District Meeting and Rubber and Plastics Technical Conference are *(left to right)*: W. H. Sammis, chairman, East Central District Meeting; AIEE President L. F. Hickernell; and AIEE Treasurer C. H. Linder, who was the keynote speaker. The meeting was held at the Sheraton Hotel, Akron, Ohio, April 22-24, 1959.

Technical Sessions

High-Voltage Cables. In a session devoted to high-voltage cables, L. I. Komives of The Detroit Edison Company discussed a program for the development of extra-high-voltage cable systems through the co-operative effort of manufacturers, educational institutions, and power utilities. A testing station will be erected near the high-volage laboratory at Cornell University to supply the necessary voltages and currents for testing and measuring cable samples now being prepared.

Other papers in this session included "The History of High-Voltage Cable" by E. J. Merrell, Phelps Dodge Copper Products Corporation, and "Manufacturers' Viewpoint on the Production of High-Voltage Cable" by E. D. Eich, Anaconda Wire & Cable Company.

Rotating Machinery. Temperature measurement was the subject of a Thursday morning session sponsored by the AIEE Rotating Machinery Committee. A paper by C. E. Green, T. Spink, Jr., and D. Vandeventer, all of Leeds & Northrup Company, described problems in measuring motor winding temperatures. J. E. Shea of Underwriters' Laboratories, Inc., discussed measurement of rapidly changing temperatures. In "Temperature Measurement of Fractional Horsepower Motors," W. R. Van Dyke, Westinghouse Electric Corporation, described results of tests made on several motors using different methods of installing thermocouples on the windings in order to obtain a direct comparison of these methods.

Industrial Heating. In the first of three papers on industrial heating, George Grant III, Dow Corning Corporation, presented information on the electrical performance of submerged arc silicon smelting furnaces. These furnaces are extremely exacting in their requirements for precise operation, in order that undesirable performance as well as unreasonable demands on the electricity supplier may be prevented.

Other papers were "New Induction Heating Applications" by J. Edwards and W. C. Ekin of Westinghouse, and "Industry's Newest Potential—Dielectric Heating" by Carl Loper of Allis-Chalmers Manufacturing Company.

Industrial Lighting. Morgan Christensen of the General Electric Company discussed "New Concepts for Meeting Human Needs with Light." He described the four basic building blocks of visual research—size, brightness, contrast, and time

(Continued on p. 765)

Schedule of AIEE General and District Meetings

MEETING	DESIGNATION	NAME OF MEETING	CONVENTIONAL SCHEDULE	1959			1960			1961			1962			1963			1964			INVITATIONS	
				DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION
GENERAL	WG	WINTER	FEB. 1ST WEEK	FEB. 1-6	NEW YORK, N.Y.	NOV. 3 1958	JAN. 31 FEB. 5	NEW YORK, N.Y.	NOV. 2 1959	JAN. 29 FEB. 3	NEW YORK, N.Y.	NOV. 1 1960	JAN. 28 FEB. 2	NEW YORK, N.Y.	OCT. 30 1961	JAN. 27 FEB. 1	NEW YORK, N.Y.	OCT. 29 1962	FEB. 2-7	NEW YORK, N.Y.	NOV. 4 1963		NEW YORK
																					65	1/31-2/5 OR 2/7-2/12
	SG	SUMMER	JUNE 3RD 4TH WEEK	JUNE 21-26	SEATTLE, WASHINGTON	MAR 23 1959	JUNE 19-24	ATLANTIC CITY N.J.	MAR 22 1960	JUNE 18-23	ITHACA, N.Y.	MAR. 20 1961	JUNE 17-22	DENVER, COLO.	MAR. 19 1962		TORONTO, CANADA			LOS ANGELES		65	MIAMI BEACH
																					67	PORTLAND, ORE.
	PG	PACIFIC	AUG.				AUG. 9-12	SAN DIEGO, CALIF.	MAY 10 1960	AUG. 23-25	SALT LAKE CITY, UTAH	MAY 25 1961		SAN FRANCISCO CALIF.		AUG. 20-23	SPOKANE, WASH.	MAY 23				67	PORTLAND, ORE.
	FG	FALL	OCT.	OCT. 11-16	CHICAGO, ILL.	JUNE 12 1959	OCT. 9-14	CHICAGO, ILL.	JUNE 10 1960	OCT. 15-20	DETROIT, MICH.	JUNE 14 1961		CHICAGO, ILL.			CHICAGO, ILL.			CLEVELAND, OHIO (TENTATIVE)			
DISTRICT	D1	EMPIRE	EARLY MAY	APR. 29 MAY 1	SYRACUSE, N.Y.	JAN. 29 1959																	
	D2	MIDDLE EASTERN	MAY	MAY 19-21	BALTIMORE, MD.	FEB. 10 1959		(SGM)		MAY 2-4	PITTSBURGH, PA.	FEB. 1 1961	MAY 14-16	ERIE, PA.	FEB. 13 1962								
	D4	SOUTH EAST	LATE MAR. EARLY APR.	APR. 8-10	ATLANTA, GA.	JAN. 9 1959				APR. 5-7	NEW ORLEANS, LA.	JAN. 2 1961				APR. 24-26	RICHMOND, VA.	JAN. 24					
	D5	GREAT LAKES	LATE APR.				APR. 27-29	MILWAUKEE, WISC.	JAN. 27 1960	APR. 19-21	MINNEAPOLIS, MINN.	JAN. 19 1961	APR. 18-20	FORT WAYNE, IND.	JAN. 19 1962								
	D7	SOUTH WEST	LATE MAR. EARLY APR.				APR. 4-6	HOUSTON, TEXAS	JAN. 4 1960				APR. 30 MAY 2	ST. LOUIS, MO.									
	D11	EAST CENTRAL	EARLY MAY	APR. 22-24	AKRON, OHIO	JAN. 22 1959	APR. 12-14	CHARLESTON, W. VA.	JAN. 13 1960	MAY 9-11	CLEVELAND, OHIO	FEB. 8 1961	MAY 23-25	TOLEDO, OHIO		MAY 7-9	COLUMBUS, OHIO (TENTATIVE)	FEB. 8	MAY 5-7	DETROIT, MICH. (TENTATIVE)			
	D12	NORTH EASTERN	EARLY MAY				MAY 2-4	PROVIDENCE, R.I.	FEB. 1 1960	MAY 17-19	HARTFORD, CONN.	FEB. 16 1961	MAY 9-11	BOSTON, MASS.	FEB. 9 1962	MAY 14-17	PORTSMOUTH, N.H. OR PORTLAND, ME. (TENTATIVE)	FEB. 13					
	D13	SOUTH CENTRAL	LATE MAR. EARLY APR.	APR. 8-10	JOINT WITH D4 ATLANTA, GA.	JAN. 8 1959				APR. 5-7	JOINT WITH D4 NEW ORLEANS LA.	JAN. 2 1961				APR. 24-26	JOINT WITH D4 RICHMOND, VA.	JAN. 24					
EASTER				MARCH 29			APRIL 17			APRIL 2			APRIL 22			APRIL 14			MARCH 29				

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
1958-1964 SCHEDULE OF GENERAL & DISTRICT MEETINGS

ISSUED BY:
J.D. TEBO
CHAIRMAN

Schedule of Special Technical Conferences

Date	Conference and Location	Sponsors
1959		
Aug. 23-26	Petroleum Industry, Wilton Hotel, Long Beach Calif.	AIEE Petroleum Industry Committee
Sept. 16-18	Engineering Management, Statler Hotel, Los Angeles, Calif.	AIEE–ASME
Sept. 23-25	Nonlinear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D. C.	AIEE
Sept. 27–Oct. 1	National Power, Muehlebach Hotel, Kansas City, Mo.	AIEE–ASME
Sept. 30–Oct. 1	Industrial Electronics, Mellon Institute, Pittsburgh, Pa.	AIEE–IRE
Oct. 12-14	National Electronics, Sherman Hotel, Chicago, Ill.	AIEE–IRE–EIA–SMPTE
Oct. 15-16	Fall Textile, Hotel Charlotte, Charlotte, N. C.	AIEE Textile Subcommittee
Oct. 19-21	Machine Tool, Hotel Cleveland, Ohio	AIEE Machine Tool Subcommittee
Nov. 4-6	National Automatic Control, Sheraton Hotel, Dallas, Texas	AIEE–IRE–ISA
Nov. 10-12	Electrical Techniques in Medicine and Biology, Hotel Sheraton, Philadelphia, Pa.	AIEE–IRE–ISA
Nov. 16	Appliance Technical, Biltmore Hotel, Los Angeles, Calif.	AIEE Domestic Appliances Subcommittee
Nov. 16-19	Magnetism and Magnetic Materials, Sheraton Cadillac Hotel, Detroit, Mich.	AIEE Magnetics Subcommittee
Dec. 1-3	Eastern Joint Computer, Statler Hotel, Boston, Mass.	AIEE–IRE–ACM
Dec. 8-10	National Electrical Insulation, Shoreham Hotel, Washington, D. C.	AIEE–NEMA

AIEE Future Meetings

Petroleum Industry Conference*
Wilton Hotel
Long Beach, Calif.
August 25-26, 1959

AIEE-ASME Engineering Management Conference
Statler Hotel
Los Angeles, Calif.
September 16-18, 1959
(Final date for †TP—Closed, ‡CP Syn.—July 3, CPMS—July 13)

Nonlinear Magnetics and Magnetic Amplifiers Conference (Exhibits)
Shoreham Hotel
Washington, D. C.
September 23-25, 1959
(Final date for †TP—closed, ‡CP Syn.—July 10, CPMs—July 20)

AIEE-ASME National Power Conference
Muehlebach Hotel
Kansas City, Mo.
September 27-October 1, 1959
(Final date for †TP—closed, ‡GP Syn.—July 14, CPMs—July 24)

AIEE-IRE Industrial Electronics Conference
Mellon Institute
Pittsburgh, Pa.
September 30-October 1, 1959
(Final date for †TP—July 2, ‡CP Syn.—July 17, CPMs—July 27)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 11-16, 1959
(Final date for †TP—closed, ‡CP Syn.—July 28, CPMs—Aug. 7)

National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 12-14, 1959
(Final date for †TP—July 14, ‡CP Syn.—July 28, CPMs—Aug. 7)

Fall Textile Conference
Hotel Charlotte
Charlotte, N. C.
October 15-16, 1959
(Final date for †TP—July 17, ‡CP Syn.—July 31, CPMs—Aug. 11)

Machine Tool Conference
Hotel Cleveland
Cleveland, Ohio
October 19-21, 1959
(Final date for †TP—July 21, ‡CP Syn.—Aug. 4. CPMs—Aug. 14)

AIEE-IRE-ISA National Automatic Control Conference
Sheraton Hotel
Dallas, Tex.
November 4-6, 1959

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference (Exhibits)
Sheraton Hotel
Philadelphia, Pa.
November 10-12, 1959
(Final date for †TP— Aug. 12, ‡CP Syn.—Aug. 28, CPMs—Sept. 7)

Appliance Technical Conference
Biltmore Hotel
Los Angeles, Calif.
November 16, 1959
(Final date for †TP—Aug. 18, ‡CP Syn.—Sept. 1, CPMs—Sept. 11)

Magnetism and Magnetic Materials Conference
Sheraton Cadillac Hotel
Detroit, Mich
November 16-19, 1959
(Final date for †TP—Aug. 18, ‡CP Syn.—Sept. 1. CPMs—Sept. 11)

AIEE-IRE-ACM Eastern Joint Computer Conference
Statler Hilton Hotel
Boston Mass.
December 1-3, 1959
(Abstracts and Summaries—Aug. 15)

AIEE-NEMA Second National Conference on Application of Electrical Insulation
Shoreham Hotel
Washington, D. C.
December 8-10, 1959
(Final date for †TP—Sept. 9, ‡CP Syn.—Sept. 25, CPMs—October 5)

AIEE-IRE-ASQC Symposium on Reliability and Quality Control
Hotel Statler
Washington, D. C.
January 11-13, 1960
(Abstracts—June 15, final papers—Oct. 15)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 31-February 5, 1960
(Final date for †TP—Nov. 2, ‡CP Syn.—Nov. 17, CPMs—Nov. 27)

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 11-12, 1960
(Final date for †TP—Nov. 12, CP Syn.—Nov. 27. CPMs—Dec. 8)

EJC Nuclear Congress
New York, N. Y.
April 3-8, 1960

Southwest District Meeting
Shamrock-Hilton Hotel
Houston, Tex.
April 4-6, 1960
(Final date for †TP—Jan. 4, DPMs—Jan. 29)

East Central District Meeting
Daniel Boone Hotel
Charleston, W. Va.
April 12-14, 1960
(Final date for †TP—Jan. 13, DPMs—Feb. 5)

AIEE-ASME-IRE Automatic Techniques Conference
Cleveland, Ohio
April 18-20, 1960
(Final date for †TP—Jan. 19, ‡CP Syn.—Feb. 2, CPMs—Feb. 12)

Great Lakes District Meeting
Hotel Pfister
Milwaukee, Wis.
April 27-29, 1960
(Final date for †TP—Jan. 28, DPMs—Feb. 22)

North Eastern District Meeting
Sheraton Biltmore Hotel
Providence, R. I.
May 2-4, 1960
(Final date for †TP—Feb. 2, DPMs—Feb. 26)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Washington, D. C.
May 10-12, 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Farm Electrification Conference
Sheraton-Fontenell Hotel
Omaha, Nebr.
May 10-12, 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Electrical Problems in the Cement Industry Conference
Milwaukee, Wis.
May 17-19, 1960
Syn.—March 4, CPMs—March 14)
Syn.—March 4, CPMs—14)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Authors Guide*
For a copy, write to E. C. Day AIEE, 33 W. 39th St., New York, N. Y.

(*Continued from p. 762*)

—and how concepts of proper lighting have changed over the past 50 years. Studies are now being made to determine the light and lighting requirements that will return the maximum net profit to the user.

Other papers presented at this session were "High-Frequency Fluorescent Lighting Systems" by W. H. Johnson, Lighting Division, Westinghouse Electric Corporation, and "Lighting from the Industrial User's Viewpoint" by D. J. Rose, Babcock & Wilcox Company.

AIEE Members See High-Voltage Demonstrations

More than 200 AIEE members and their wives attended the Ohio Brass Company's (O-B) high-voltage demonstrations on the evening of April 22. They were driven to the O-B Barberton laboratory from Akron, Ohio, after attending the AIEE East Central District meeting's first day of sessions.

During the Faraday cage demonstration, J. H. Foote, chief engineer, Commonwealth Associates, Inc., of Jackson, Mich., and president-elect of AIEE, volunteered to be seated in the Faraday cage for a demonstration while a 285-kv current crackled over the stacking posts and copper screened cage.

Other demonstrations included showing RIV and corona on a 345-kv dual conductor; 60-cycle flashover on a GK-55 condenser bushing; pinwheels on high 60-cycle voltage; lightning arrester protection of a distribution transformer; and steep wave voltage drop across copper bars.

A fine attendance was recorded by the operating power companies from the district. Other guests included personnel from electrical manufacturers, communications companies, rubber companies, consulting engineering firms, and other manufacturers.

AIEE members viewed the Barberton lab informally after the demonstrations while sandwiches and coffee were served.

DISCUSSING the Faraday cage demonstration at the Ohio Brass (O-B) Barberton laboratory are *(left to right)*: W. H. Burleson, manager of the O-B power utilities department; E. L. Kanouse, City of Los Angeles Department of Water and Power; J. H. Foote, president-elect of AIEE; and R. A. Black, president of the Ohio Brass Company.

Courtesy Ohio Brass Company

EJC Reports on Income of Engineering Teachers

The average professional income of engineering teachers in the United States has risen 8.3% since 1956, and their basic teaching salaries have increased 13.5% over the 2-year period, according to a survey published for Engineers Joint Council (EJC). The survey covered more than 5,000 engineering teachers, or about half of the teachers in this field in the United States.

By the nature of their occupation, engineering teachers must do research and, therefore, earn more than their basic teaching salaries. Thus, the average total professional income of engineering teachers which was $8,862 in 1956, was $9,598 in 1958. The basic salary average rose by $894 per year, but there was a decline of 7% in outside income. Deans and department heads, however, showed an increase in both teaching and outside income.

The total income of engineering teachers in public institutions rose more than the total income of those in privately supported institutions. Engineering teachers holding advanced degrees earned more. In general, the survey showed that the teaching salaries of engineering educators increase with age. These basic salaries ranged from a low of $6,744 in the South to $8,392 in the Pacific region.

The report entitled "Salaries and Income of Engineering Teachers, 1958" is the second detailed analysis of this group based upon data collected by the engineering income surveys of EJC. The first was conducted 2 years ago under the auspices of the American Society for Engineering Education. The new report is published for EJC as a supplement to their recent report "Professional Income of Engineers —1958" and was prepared by the Bureau of Business and Economic Research located at Northeastern University, Boston, Mass.

Copies of the complete report are available from Engineers Joint Council, 29 W. 39 St., New York 18, N.Y., at 25¢ to cover handling cost.

Courtesy Ohio Brass Company

EXPLAINING the 345-kv switch stack demonstration is C. J. Miller, O-B research engineer and master of ceremonies for the evening. Laboratory technicians ground and disassemble the 60-cycle horn gap experiment. Right of the easel is the Faraday cage, and to the left and above hangs a 345-kv dual conductor.

Dayton Section Exceeds Quota

N. E. Snyder, Photo

THE DAYTON SECTION of the Institute has reached 182% of its quota for the United Engineering Center under the direction of the following Fund Drive Committee members: *(left to right)* H. E. Deardorff and D. N. Warren, co-chairmen of the Soliciting Committee; C. J. Werner, general chairman; and B. J. Pleiss, Section chairman. In July 1958, the Dayton Section started to organize its Fund Drive Committee. On September 15, 1958, a "kick-off" dinner, attended by Committee members and solicitors, officially started the drive. By October 31, the Section had exceeded its quota with approximately two thirds of its members having been contacted. To date, the Section has pledged 182% of its quota. The outstanding success of this drive is a direct result of the planning of the Committee and the work of the solicitors.

Fellow Diploma Presented

W. D. Smith—Commercial Photographer

R. D. ELLIOTT *(left)*, vice-president of Dallas Power & Light Company, receives his AIEE Fellow Diploma from E. B. Robertson *(right)*, past president of AIEE. Observing the presentation is P. G. Wallace *(center)*, of the Texas Power & Light Company, who is a national director of AIEE. The diploma was presented to Mr. Elliott on April 24, 1959, at the annual North Texas Section's joint meeting of the Dallas and Fort Worth groups. The meeting was held in Fort Worth at the Ridglea Country Club.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Progress Toward United Engineering Center

A tentative working schedule for the construction of the new United Engineering Center was adopted by the United Engineering Trustees, Inc., at its meeting on April 23, 1959. The schedule is as follows:

August 30, 1959

1. Completion of Working Drawings (by Shreve, Lamb and Harmon Associates, Architects, with the co-operation of Seelye, Stevenson, Value & Knecht, Structural Engineers, and Jaros, Baum & Bolles, Mechanical Engineers).

September 30, 1959

2. Confirmation of Guaranteed Limit of Cost by Turner Construction Co.

October 15, 1959

3. Commencement of Construction

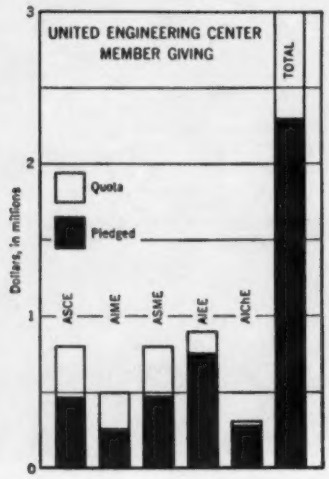
March 15, 1961

4. Completion of Construction

July 1, 1961

5. Completion of Occupants' Requirements for Occupancy

The adoption of this construction schedule does give a sense of urgency to the attainment of the subscription quotas in the Industrial and Member Gifts Campaigns at the earliest possible dates.



THE BAR GRAPH shows the status of member giving as of May 15, 1959. All contributions to the United Engineering Center Building Fund are tax deductible.

ASA Sectional Committee N3 on Nuclear Instrumentation

REPRESENTATIVES from 22 professional societies including the AIEE meet quarterly to hasten the development of standards for nuclear instruments and controls. These representatives comprise Sectional Committee N3 on Nuclear Instrumentation of the Nuclear Standards Board, a group of the American Standards Association (ASA).

In its deliberations, the Committee is attempting to set up means for adoption of standards that are useful to manufacturers and users of nuclear instrument and control equipment. Careful scrutiny to assure universal concurrence by all concerned in proposed standards is made. Then the standard is published by the ASA, indicating acceptance of the proposal for general use.

As a first step in the Committee's functioning, a survey of standards in existence or in the process of preparation was made. The results have been summarized and published by R. F. Shea as "Index of Nuclear Standardization Work." (Copies can be obtained by writing to L. G. Cumming, Technical Secretary, The Institute of Radio Engineers, Inc., 1 E. 79th Street, New York 21, N. Y.)

The scope of the work of the Committee is officially stated as follows:

> "Standards, specifications and methods of testing for instrumentation in the nuclear field including instrumentation for personnel protection, reactor control, industrial processes, analysis and laboratory work, radiation calibration equipment and components therefor."

To break this into more specific areas of interest, Dr. A. B. Van Rennes developed a topical structure of the fields of interest of the Committee.

The topical structure is based on the recognition that:

A. One must first have an adequate set of definitions.

B. Standards required in the industry fall into four separate categories, which in general apply to every nuclear instrument or major component thereof:

1. *Measurement* of variables (neutron flux, dose rate, detector output signal, etc.)
2. *Calibration* of radiation sources, components (including detectors), electronisms, and complete instruments.
3. *Methods of testing.*
4. *Design and manufacturing* standards.

C. Nuclear instrumentation equipment generally consists of an input transducer (detector), followed by some type of electronism (which includes an output transducer). The detector receives its stimulus from a test source or a radiation field. In certain instances, such as for dosimeters or thickness gages, it will be desirable to write standards* on complete instruments, rather than components. In such cases, an instrument is considered to include a detector, an electronism, and perhaps a radiation source.

Through the International Electrotechnical Commission (IEC), the N3 Committee is planning to participate in the formulation of international standards. Technical Committee 45 was authorized by the IEC in 1958. Germany (Dr. Richard Vieweg) was established as the Secretariat. The United States was designated to nominate the Chairman. The N3 Chairman has subsequently been nominated by the United States for the position of Chairman to TC 45. R. F. Shea has been nominated as the United States delegate to the Committee. The opening meeting is planned for late 1959.

The N3 Committee operates under two fundamental principles, following the precepts of the ASA:

1. Organizations or groups substantially concerned with the subject matter of a standard, whether a member of ASA or not, have an inherent right to have their views fully considered in the development and approval of an American Standard.
2. An American Standard can be initiated and approved only if a consensus exists of all groups who are substantially concerned with the scope and provisions of the standard.

Any standards or specifications believed to be acceptable for ASA adoption should be brought to the attention of the Association.

*One is tempted here to use the word "specification." However, for purposes of this discussion, a specification is defined to be a set of requirements for an instrument as established by a customer or a manufacturer. A set of specifications may in turn rely upon, refer to, or incorporate various standards as supporting material.

Materials Handling Conference

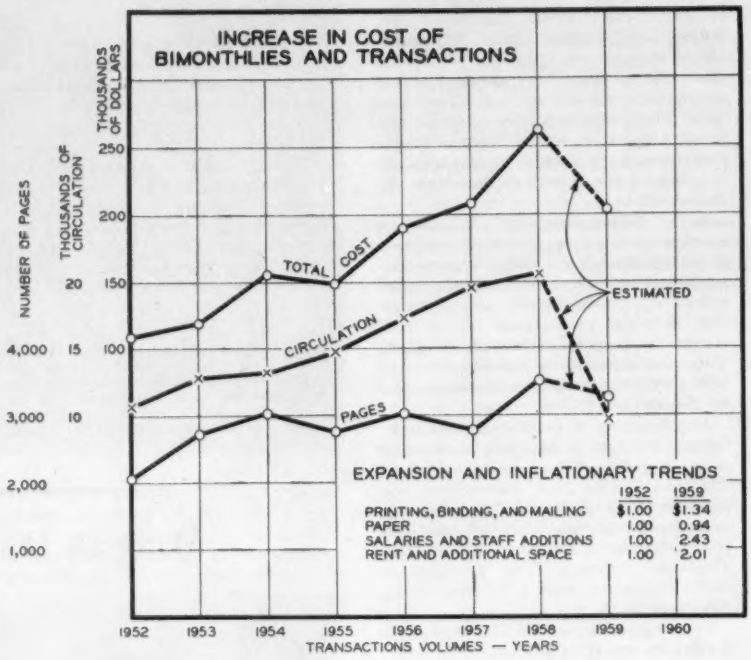
J. L. SINGLETON (*seated, right*) president of the National Electrical Manufacturers Association (NEMA) and vice-president, Industries Group, Allis-Chalmers Manufacturing Company, spoke to an overflow crowd on the "Economic Challenge of Russia" at the AIEE Materials Handling Conference, April 14-15, 1959, in Milwaukee, Wis. J. M. Frank, (*seated, left*), of the Hevi-Duty Electric Company, was general chairman of the Local Committee on Arrangements. Standing (*left to right*) are: H. E. Meisel, Square D Company, chairman, Entertainment Committee; A. A. Cygal, Westinghouse Electric Corporation, assistant general chairman; W. C. Rhine, Cutler-Hammer, Inc., chairman, Registration Committee; L. D. Hall, Cutler-Hammer, Inc., chairman, Mailing Committee; and G. H. Manke, Line Material Industries, chairman, Finance Committee. The other Local Committee chairmen not shown in the photo were: K. J. Renish, Bucyrus-Erie Company, secretary; A. J. Sielicki, A. O. Smith Corporation, Meeting Facilities Committee; J. S. Hart, Allen-Bradley Company, chairman, Technical Program; E. E. Mahaupt, Harnischfeger Corporation, chairman, Printing Committee; H. E. Whiting, Square D Company, chairman, Inspection Trips; R. E. Horn, Allis-Chalmers Manufacturing Company, chairman, Publicity; and R. Ladner, Milwaukee School of Engineering, chairman, Student Representation. E. J. Posselt of Cutler-Hammer, Inc., is chairman of the AIEE Materials Handling Subcommittee. Buffalo, N. Y., was chosen as the location for the 1960 Materials Handling Conference.

Subscriptions To Technical Periodicals and AIEE *Transactions*

AFTER the increased prices for subscriptions to the Technical Periodicals (bimonthlies) and the AIEE *Transactions* were announced (*Electrical Engineering*, July 1958, p. 632), some members inquired as to why the Technical Periodicals (bimonthlies) no longer could be received in consideration of payment of dues.

As is the case with almost everything else over a period of years, there has been a considerable inflationary increase in printing prices. Also, the increase in number of pages published and the increase in circulation have been appreciable. For example, since July and August of 1952 when these publications were first introduced, the number of pages published has increased from 2,068 to 3,516. The combined circulations have increased from an average of 10,600 to an average of 20,700; while total costs per year have increased from $107,700 to $254,617. A 70% increase in the number of pages published requires nearly twice as many people to do the work as were required in 1952 and nearly double the floor space. Printing, binding, and mailing have gone up 34%. These trends of increase in cost of production and circulation of the Technical Periodicals (bimonthlies) and *Transactions* are shown in the accompanying figure. In view of these facts, it was necessary to increase the subscription prices to these publications as announced last July.

While the income from member subscriptions has not yet been fully realized, the income from subscriptions to these publications has increased only slightly over the years and at the close of the fiscal year on April 30, 1959, it was only $71,757, while expenses were $254,617, a deficit of $182,860. Different methods of production and distribution have been studied and printing estimates obtained, but so far, no other method has been found which is more economical. Further increases in subscription prices to these publications may become necessary.



AIEE *Transactions*

Volume 77 of the AIEE *Transactions* for 1958, containing 3,516 pages completely indexed, is available for distribution. The volume is bound in three separate parts, each in cloth gold embossed with a stiff cover. Part I and II contain the papers published in the two Technical Periodical (bimonthly) publications *Communication and Electronics* and *Applications and Industry* in the six consecutive issues beginning with March 1958 and ending with January of the following year. Part III, *Power Apparatus and Systems*, contains all of the papers in the six consecutive issues of this Technical Periodical (bimonthly) publication from April 1958 to February of the following year. If Volume 77 has not already been ordered, orders should be placed promptly while the supply lasts. Ordering information and prices appear in the accompanying tabulation.

Subscription Prices to Technical Periodicals (Bimonthlies) and *Transactions*
Approved by Board of Directors April 30, 1958
Effective August 1, 1958

Technical Periodical (Bimonthly) Publications	Member Prices (annually)	Nonmember Prices (annually)
Communication and Electronics	$5.00†	$8.00‡
Applications and Industry	5.00†	8.00‡
Power Apparatus and Systems	5.00†	8.00‡

†Members may receive one subscription to any *one* of the bimonthlies for $2.50. The balance of the $5.00 subscription price shown above will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional subscriptions will be at the $5.00 rate shown above.

‡Subscription price and 50¢ extra for foreign postage both payable in advance in New York exchange.

Single copies may be obtained when available	$1.50 each	$1.50 each

AIEE *Transactions*

Part I. *Communication and Electronics*	$4.00	$8.00**
Part II. *Applications and Industry*	4.00	8.00**
Part III. *Power Apparatus and Systems*	4.00	8.00**
Annual combination subscription to all three parts	10.00	15.00***
Annual combination subscription to any two parts		12.00***

**Subscription price and 75¢ extra for foreign postage both payable in advance in New York exchange.

***Subscription price and $1.00 extra for foreign postage both payable in advance in New York exchange.

Electrical Engineering* and *Transactions

An annual combination subscription to both publications (effective August 1, 1958) ....$24.00§
§Subscrption price and $2.00 extra for foreign postage both payable in advance in New York exchange.

Discount 25% of above nonmember prices to college and public libraries. Publishers and subscription agencies 15% of above nonmember prices. For available discounts on Standards and special publications, obtain price lists from Order Department at Headquarters. Send all orders to:

Order Department
American Institute of Electrical Engineers
33 W. 39th St., New York 18, N. Y.

Stanert Photo

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MAIN SPEAKER at the April dinner meeting of the Los Angeles Section of the AIEE (above, *left*) was Dr. F. C. Lindvall, who discussed engineering education in the USSR. Seated are (*left to right*): L. L. Grandi, director; R. D. Turpen, chairman, Student Relations Committee; Dr. Lindvall; F. L. Goss, director; E. D. Barcus, Section chairman, 1958-59. Above, *right*: Students from University of Southern California (USC), University of California at Los Angeles (UCLA), California State Polytechnic College, and Los Angeles State College were in attendance at the April dinner meeting. Some of the students show Mr. Barcus (*standing*) the results of their studies (*seated, left to right*): Charles Evans, USC; Ronald Malonosky, USC; Rand Sherwin, UCLA; (*standing, left to right*): Edward Harper, Charles Jones, Bob Kirby, John Figueira, Rogers Harder, all of California Poly; Phil Chalfin, Los Angeles State; Charles Reynolds, Clinton Bashore, UCLA.

Los Angeles Section Announces New Officers

Fred Foulon, Douglas Aircraft Company, has been elected chairman of the Los Angeles Section of AIEE for the year 1959-60 beginning June 1, 1959. The announcement was made by E. D. Barcus, outgoing chairman, at the annual "Ladies Night" banquet.

Mr. Foulon, with an M.S. degree in E.E. from the California Institute of Technology, is a registered professional engineer. He served last year as vice-chairman of the Los Angeles Section. In Douglas Aircraft Company, Mr. Foulon is in charge of specialized electronics research for military applications. He is identified for his work with advanced research in military communications systems. He is a member of the U.S. Air Force, Navy Advisory Staff on Aircraft Electrical Systems.

Those elected at the same time were: Vice-Chairman Robert Milmoe, supervising engineer, Bechtel Corporation; Secretary-Treasurer L. L. Grandi, professor of electrical engineering, University of California at Los Angeles; Director No. 1—Professional Development and Recognition, W. S. Moody, General Electric Company; Director No. 2—Technical Operations, Phil Belsky, Westinghouse Electric Corporation: Director No. 3—Technical Operations, W. H. Wedel, The Pacific Telephone and Telegraph Company; Director No. 4—Administration, L. W. Swanson, C. F. Braun and Company.

Division Chairmen will be chosen by their own groups and Committee Chairmen and Committee Members will be appointed.

At the Los Angeles Section's April dinner meeting, Section members and students from the local universities and colleges heard about engineering education in the United States and the USSR.

Students from California State Polytechnic (Pomona and San Louis Obispo), Los Angeles State, University of Southern California, and University of California at Los Angeles (UCLA) talked with the members about their respective institutions. The students from UCLA and California Poly (Pomona) arranged displays showing the results of their studies.

The speaker for the evening was Dr. F. C. Lindvall, chairman of Division of Civil, Electrical, Mechanical Engineering, and Aeronautics at California Institute of Technology. Dr. Lindvall, who was chairman of the American Society for Engineering Education Exchange Mission that toured USSR engineering schools, outlined the objectives and methods of the Soviet educational program.

Recent Activities of the Philadelphia Section

Dr. V. K. Zworykin, honorary vice-president and director, David Sarnoff Laboratories of the Radio Corporation of America (RCA), addressed the March meeting of the AIEE Philadelphia Section on the Subject, "Present Status of Electronic Motor Vehicle Control Research."

He described the program and objectives for the automatic control of motor vehicles. He said the basic control is installed in the road itself. The system will detect the presence and speed of vehicles and communicate this information to drivers of other vehicles, either by indicators along the road or within the car. In addition, the installation will provide guidance signals on a dashboard indicator to enable the driver to keep the car centered on the road.

In a more advanced system, the guidance system will act directly on the power steering mechanism of the car and control the speed in the presence of a car ahead.

At the present time, only limited tests of the road installation for detection and guidance have been carried out. The major immediate need is a full-scale test facility for studying the complete system under conditions approximating actual highway conditions.

Dr. Zworykin joined RCA in 1929 to head the Electronic Research Laboratory. Since 1954, he has assumed, in addition to his responsibilities at the RCA Laboratories in Princeton, N.J., the direction of a Medical Electronics Center at the Rockefeller Institute for Medical Research in New York. In recognition of his important contributions, Dr. Zworykin has been awarded an honorary degree of doctor of medicine from Polytechnic Institute of Brooklyn, the Medal of Honor and the Morris Leibmann Memorial Prize of the Institute of Radio Engineers (IRE); the Edison Medal and the Lamme Medal of the AIEE; the Progress Medal of the Society of Motion Picture and Television Engineers (SMPTE); the Rumford Medal of the American Academy of Sciences; the Potts Medal of the Franklin Institute; the Presidential Certificate of Merit; the Chevalier Cross of the French Legion of Honor; and many others.

At the April Section meeting, two City of Philadelphia engineers discussed the city's communications and traffic control system.

E. P. Grim, chief, Division of Communication Services, described the telephone, teletype, radio, and microwave systems which link the city's communication network. He discussed their normal operation and also disclosed the emergency provisions which have been made to carry on communications in event of a major disaster.

H. B. Murray, the city associate traffic engineer, spoke on the new electronic traffic control system. Indicators buried in the streets, as well as overhead traffic detectors, count the number of cars flowing into and

Photographed by Photo-Arts

NEWLY ELECTED OFFICERS for the 1959-60 season of the Philadelphia Section are: (left to right) Chairman—R. S. Hewett, Minneapolis-Honeywell Regulator Co.; Vice-Chairman—R. L. Halberstadt, Bell Telephone Co. of Pennsylvania; Secretary—W. O. Mascaro, Atlantic Refining Co.; Treasurer—W. C. Bloomquist, General Electric Company; Chairman of the Atlantic City Division—R. C. R. Schulze, Atlantic City Electric Co.

out of key points in the major arteries of the city. This data is collected in computer equipment which sets up the timing system and relays the information out to the traffic control standards.

New Section officers were elected for the 1959-60 season. They are: Chairman—R. S. Hewett, Minneapolis-Honeywell Regulator Co.; Vice-Chairman—R. L. Halberstadt, Bell Telephone Co. of Pennsylvania; Secretary—W. O. Mascaro, Atlantic Refining Co.; Treasurer—W. C. Bloomquist. General Electric Company; Managers for two years—R. G. Lex, Jr., Leeds & Northrup Co., J. W. Pobst, Naval Air Development Center, G. L. Hollander, Philco Corp., and E. F. Jones, United Engineers & Constructors, Inc. Still Managers for an unexpired term of one year are: R. T. Ferris, Philadelphia Electric Co.; Prof. F. C. Powell, Drexel Institute of Technology; T. H. Story, RCA; and B. B. Young, The Franklin Institute.

The Educational Committee of the Philadelphia Section jointly sponsored a spring lecture series with IRE on the subject: Automation and Process Control.

Seven sessions were held on the following subjects: Control System Theory, Industrial Regulators and Controllers, Electronic Process Control, Data Handling, Static Switching Devices, Digital Control of Machine Tools, and Typical Applications. The average attendance at each session was about 100 engineers.

EJC Supports Department of Science and Engineering

Engineers Joint Council (EJC), representing more than a third of the nation's engineers, solidly backed the creation of a Cabinet-level Department of Science and Engineering, in a statement before the Subcommittee on Reorganization and International Organizations of the Senate Committee on Government Operations at a Washington, D. C., hearing on April 16. EJC was represented at the hearing by E. R. Needles, president, and A. B. Kinzel, vice-president, of the organization.

"Engineers Joint Council supports in principle the creation of a Cabinet-level Department for Science and Engineering," Mr. Needles told the subcommittee, chaired by Senator Hubert H. Humphrey (Dem.) of Minnesota, "basically at the administrative level, the better to service our national economy and our national defense, but we would emphasize that science and engineering, directly pertinent to the missions of certain departments, must continue to be carried out within these departments."

Mr. Needles condemned the indiscriminate use of what he called a "restrictive word," that is, "Technology" and deplored it as a substitute for the word "engineering."

"We strongly urge that any administrative development in this field be properly identified as "Science and Engineering," not only as a matter of recognition, but also as a matter of clearly setting forth the intent of the measures to include the field of engineering activities. "Our recommendation," he continued, "has far broader implications than one based on a concern for semantics. We fear that much of the planning in Government has failed to consider this implication properly and we take exception to the undue emphasis on "science," even when used in the broad sense. Although the intention may be to include engineering, this is only apparent to those using the word and not to their audiences."

He cited engineering as "a profession in which a knowledge of mathematics and natural sciences gained by study, experience, and practice, is applied with judgment to develop ways to utilize economically the materials and forces of nature for the progressive well-being of man."

Mr. Needles advocated a Department of Science and Engineering which would have not only responsibility, but also the authority to act. He pointed out to the subcommittee that activities in science and engineering had progressed and are progressing so rapidly that new demands are constantly being made of Government, industry, and higher education; and the activities of engineering have widened to a point where responsible leadership in Government is needed to bring about an efficient and fully developed long-range program for science and engineering.

"Under the current diversity of organizational effort, there is real danger that important areas of new knowledge will not receive the attention and research support they merit," Mr. Needles concluded. "We are speaking, of course, of those areas in which integrated planning by the Government is required because of the enormous scope of the problems and because it represents the welding of many joint intellectual efforts . . . We recommend that particular care be exercised in the transitional phases of reorganization which would accompany the creation of this proposed new department."

The EJC statement concluded that the new department should bring together the activities of a broad engineering and scientific nature not directly pertinent to the missions of other departments and should, in addition, co-ordinate science and engineering in such departments by some device such as The Federal Council for Science and Technology, recently established, in order to insure the development of balanced programs, prevent dissipation of efforts, and insure the preservation of our excellence in the fundamental areas of science and engineering.

EJC is a non-Government, nonprofit federation of 21 societies of professional engineers with an aggregate membership of 300,000.

Electrical Conference of the Petroleum Industry

Electrical engineers of the Petroleum Industry have a unique challenge today—to further reduce costs in the world's most highly automated industry. This goal is being accomplished by the use of new and revolutionary ideas which include the application of electrical controls and power by the next step of automation—"electromation." These ideas will be presented at the 6th Electrical Conference of the Petroleum Industry to be held August 23-26, 1959, at the Wilton Hotel in Long Beach, Calif.

The Conference will present top management views in four areas vital to progress in the industry: (1) the 1959-60 President of AIEE—J. H. Foote, chief engineer of Commonwealth Associates, Inc.; (2) a speaker from a major producer—Reese Taylor, chairman of the board of directors

of Union Oil Company; (3) a representative of a major supplier of electrical equipment—A. F. Vinson, vice-president and group executive of the General Electric Company; and (4) a speaker from a major electric utility—J. F. Davenport, executive vice-president of the Southern California Edison Company. The remarks of these representatives will keynote the Conference and help to broaden the ideas of the highly specialized electrical engineers in attendance.

The three Subcommittees—Production, Transportation, and Refining, under the direction of Chairman H. M. Stewart, have reviewed the latest electromation developments in their respective fields. Program material has been prepared which will provide information vital to the industry in respect to more efficient production with less expenditure.

Electromation in the Petroleum Industry will be discussed in Transportation Subcommittee papers on the following subjects: the Union Oil Company's San Pedro Supertanker facility; the future place of computers in pipeline control; the application of automatically controlled, large synchronous motors to gas transmission systems; the use of solid-state supervisory control equipment; communications and control of a 225 mile pipeline by remote microwave control system; electric couplings for variable speed drive of pipeline pumps; electrical features of the proposed transwestern pipeline; and a panel discussion on classification of hazardous areas—in general, gas plants and liquid plants. The Production Subcommittee program, which also emphasizes the electromation theme, will include papers on automatic controlled gas turbine generation; the use of 762-volt cable; the alternating current off-shore drilling equipment used by the Standard Oil Company supplied through 16-kv submarine cable 2 miles off shore at Summerland, Calif.; the application of digital telemetering; automatic custody control; and repressuration of the Long Beach subsidence area. The Refining Subcommittee, which has prepared a program showing the cost reduction progress made and planned for further electromation, will present papers on power distribution to refinery process units; overhead and underground distribution experiences; static switching for gas turbine control; electrical design highlights and remote control of refinery tank-farm equipment. The Production Subcommittee chairman is C. H. Eckel, Humble Oil Refining Company; the Transportation Subcommittee chairman is C. D. Catt, El Paso Natural Gas Company; and the Refining Subcommittee chairman is L. B. Eddy, Universal Oil Products Company.

The field trips which have been planned will also emphasize electromation progress and planning. In order to broaden the knowledge of specialized electrical petroleum engineers, the transportation and refining field trip will be combined. This trip will include a visit to the termination and control center for the Four Corners Pipeline; the termination and control center for the Southern Pacific Pipeline; the new Richfield Oil Company refinery; the Union Oil Company's Supertanker unloading facility; and the electric repressuration station for subsidence in Long Beach. The production field trip will view the Texas Oil Company's Monterey, Calif., off-shore production facility; examples of electric bottom hole heating and electric heating of field pipeline gathering facilities, the Shell Oil Company's Brea automatic control electric pumping field; and the historic Signal Hill field.

ELECTROMATION in the Petroleum Industry is well illustrated by the Union Oil Company's microwave, automatic, remotely controlled San Joaquin Valley Pipeline. A paper on Union's operation, design, and control will be presented at the 6th Annual Electrical Conference of the Petroleum Industry, Long Beach, Calif., August 23-26, 1959.

Approximately 700 electrical engineers are expected to attend the Conference in order to review recent progress and future planning in electromation of the Petroleum Industry.

Translation of Soviet "Magnetic Amplifiers"

During 1958, the AIEE Magnetic Amplifier Theory Subcommittee carried out the task of translating the Russian book "Magnetic Amplifiers," by M. A. Rosenblat. The objective of this activity was to discover any new technical information beyond that which was known in this country in the magnetic amplifier field. The following members of the subcommittee volunteered to carry on this activity:

Member	Chapter
R. C. Barker	1, 2
F. J. Friedlaender	3
I. Leliakov	3
L. A. Finzi	4
R. W. Roberts	5
H. C. Bourne	6
P. P. Biringer	7
G. F. Pittman and R. A. Ramey	8
G. C. Feth	9
A. B. Rosenstein	10, 11
R. M. Hubbard	12
H. L. Goldstein	13
D. Feldman	14, 15

The book contains over 800 pages, and hence many hours of work were required by this activity. In most cases, the committee members sat down with the translator to discuss the material while it was being translated, thereby obviating the need for a verbatim translation of the entire material. Nevertheless, considerable expenses were involved for the translating activity.

At the conclusion of the work, the unanimous opinion was that there did not appear to be very much technical information in the book not previously known in the United States. This was somewhat disappointing. On the other hand, we were not disappointed with the implication that the state of the magnetic amplifier art in the USSR did not appear to be advanced beyond nor completely abreast of the state of the art in this country, at least at the time (1954, 1955) when the book was written.

Some items of interest are as follows:

1. The core materials appear to be similar to those used in this country. For example, there was a material with the same maximum flux density and d-c coercive force as Deltamax or its equivalent.

2. The methods used to analyze the magnetic amplifier did not appear nearly as rigorous, nor as comprehensive as the methods described in published books in this country.

3. In the rectifier chapter, the major discussions were relative to copper oxide and selenium units. Germanium rectifiers were mentioned, but not silicon rectifiers.

4. In general, no discussion of the physics of magnetization was included. Essentially, only the terminal properties of the rectifiers and cores were discussed at length.

Prof. R. C. Barker of Yale had translated the Preface of the book and it indicated that a fourfold advancement in the technical area including magnetic amplifiers was contemplated for the next 5 year plan for economic development in USSR. Thus, although at the time of the preparation of this book, the magnetic amplifier art in this country was perhaps somewhat advanced beyond that in the Soviet Union, this may not now be the case, as indicated by recent Soviet technical articles.

The following items are available in magnetic amplifier subcommittee files should anyone be interested in further details on the book: (1) a translated listing of all section headings and figure captions, (2) complete English translations for Chapters 8 and 13, (3) translated copies of the core material data of Chapter 3.

Recording and Controlling Instrumentation Conference

The AIEE Recording and Controlling Instrumentation Committee held its 3rd National Conference at the Bellevue-Stratford Hotel in Philadelphia, Pa. on April 20-21, 1959. With the co-operation of the American Society of Mechanical

SOME MEMBERS of the AIEE Recording and Controlling Instrumentation Committee present at their 3rd National Conference were *(front row, left to right)*: **J. E. Casey, J. W. Percy, A. W. Jacobson, W. P. Wills, R. E. Murray, R. Mayer,** *(back row, left to right)*: **F. H. Zimmerli, W. P. West, P. B. Robinson, J. P.. Lienesch, R. S. Gardner, H. Kockritz.**

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until July 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before July 27.

57-130 **A New Stator Coil Transposition for Large Machines.** *S. L. Ringland, L. T. Rosenberg*

58-1242 **Two Examples of Industrial Research in France Relating to the Transmission of Electric Energy.** *F. M. Cahen, R. A. Tellier*

58-1274 **Tests on Protective Gaps for Distribution Series Capacitors.** *H. E. Weaver, N. M. Neagle*

58-1288 **Preparation of Aluminum Conductors for Stable Electrical Connections.** *M. R. Monashkin*

58-1300 **Training Simulator for Nuclear Power Plant Reactor Operators.** *N. E. Bush*

58-1353 **The St. Lawrence River High-Voltage Submarine Cable Crossing. Part III. Installation.** *D. M. Farnham, G. B. Shanklin, S. H. Cunha, H. D. Short*

58-1354 **The St. Lawrence River High-Voltage Submarine Cable Crossing. Part IV. Field Tests After Installation and Conclusion.** *D. M. Farnham, G. B. Shanklin, S. H. Cunha, H. D. Short*

59-138 **Rotor Impedance Control of the Wound-Rotor Induction Motor.** *W. Shepherd, G. R. Slemon*

59-143 **Synthesis of Double-Cage Induction-Motor Design.** *H. E. Jordan*

59-189 **Rationalization of Electrical Clearances for Applications at Extra-High Voltages, 230 Kv to 460/500 Kv.** *P. L. Bellaschi*

59-496 **A 35-Kv Polyethylene-Insulated Cable Installation.** *G. J. Crowdes*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N.Y.

Engineers, Institute of Radio Engineers, and Instrument Society of America, the 444 registered attendees in seven sessions were presented with 34 papers devoted to analog and digital instrumentation. The first session was devoted to engineering education for instrumentation, and the remaining six sessions to components, systems, and data handling and processing for analog and digital control. A. W. Jacobson is chairman of the Committee, and the Philadelphia Section host committee was under the direction of R. Mayer. Proceedings of the Conference are available at AIEE Headquarters.

Plans for 2nd Conference on Electrical Insulation

Latest developments in the field of electrical insulation, so vital to both national defense and industry, will be exhibited at the 2nd National Conference on the Application of Electrical Insulation, to be held in Washington, D. C., December 8-10, 1959.

The first national conference of this type, co-sponsored by the AIEE and the National Electrical Manufacturers Association (NEMA), was held in Cleveland, Ohio, in September 1958. Success of that meeting led to the establishment of the second conference, which will have its headquarters at the Shoreham Hotel.

Chicago, Ill., has been chosen as the site for the 1960 meeting.

At Washington, there will be commercial exhibits by manufacturers of all types of insulation, technical exhibits, including interesting exhibits from Government agencies, and educational exhibits, provided by manufacturers of electrical equipment to illustrate major uses of various types of electrical insulation materials.

With rockets and missiles, as well as jet planes and industrial machinery for peaceful pursuits, today operating at temperatures unattainable 15 years ago, the search for new insulating materials and the improvement of old reliable ones such as mica and asbestos is expanding rapidly. The trend toward miniaturization has also brought about many new problems. These are only a few of the phases of the field of electrical insulation which will be dealt with at the Conference.

A. E. Bohn, of Electro-Technical Products Division, Sun Chemical Corporation, Nutley, N. J., is chairman of the Exhibits Committee. Other members are W. J. Dwyer, Suflex Corp., Woodside, L. I., N. Y.; N. P. Hickok, Permacel-LePage's Inc., New Brunswick, N. J.; C. Keiter, Permacel-LePage's Inc., Bedford Park, Ill.; R. G. Tiffany, Dow Corning Corporation, Chicago, Ill.; J. A. Williams, D. C. Dolph Co., Monmouth Junction, N. J.; F. J. Campbell, U.S. Naval Research Laboratory, Washington, D. C.

The conference management has decided to make no charge for space for technical and educational exhibits. Details regarding the 200 exhibit spaces available for commercial exhibits will be forwarded soon to concerns engaged in the field of electrical insulation.

Call for Papers Computer Conference

The 1959 Eastern Joint Computer Conference (EJCC), sponsored by AIEE, Association for Computing Machinery, and Institute of Radio Engineers, will be held at the Statler Hilton Hotel, Boston, Mass., on December 1-3, 1959. Papers will be accepted on any phase of computing. Persons wishing to present papers should submit by August 15, 1959, four copies of a 100 word abstract and a 1,000 word summary. Present plans call for a single session conference, and papers will be limited to a presentation time of 20 minutes followed by a brief discussion period. At the discretion of the program committee, papers of exceptional interest may be allowed a longer period of time for presentation, provided written request by the author is made at the time the abstract and summary are submitted. Abstracts should be suitable for inclusion in the program of the Conference. It is requested that summaries be submitted which accurately describe the author's work in order to assist the program committee in selecting papers of greatest merit.

The chairman of the Conference will be F. E. Heart, Lincoln Laboratory, Lexington, Mass., and H. W. Fuller, Laboratory for Electronics Inc., Boston, Mass., will direct the local arrangements. Exhibit management will be handled by John Leslie Whitlock Associates, Arlington, Va. Abstracts and summaries should be sent by August 15, 1959, to: J. H. Felker, Chairman, EJCC Program Committee, Bell Telephone Laboratories, Mountain Ave., Murray Hill, N.J., Room 5C-101.

NEC Announces October 12-14 for 1959 Sessions

The 15th National Electronics Conference (NEC) will meet October 12-14, 1959, at the Hotel Sherman, Chicago, Ill., according to V. H. Disney, president. The 1959 NEC will hold sessions in adaptive servomechanisms, antennas and propagation, audio, circuit theory, communications systems, computers, information theory, instrumentation and telemetry, masers, microminiaturization, microwaves, millimeter waves, parametric amplifiers, plasma research, radar and radio navigation, servomechanisms, signal matched filters, solid-state circuits and devices, space electronics communication and navigation, television, transistors, and value engineering.

All indications point to an attendance exceeding 10,000, said Mr. Disney. Exhibitors will fill 266 booth spaces in the Hotel Sherman.

The NEC is sponsored by the AIEE, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University, and University of Illinois. Participants are: Michigan, Michigan State, Notre Dame, Purdue, Wayne State, and Wisconsin Universities, Electronic Industries Association, and the Society of Motion Picture and Television Engineers.

Textile Conference

AIEE TEXTILE SUBCOMMITTEE MEMBERS attending Textile Conference at Atlanta, Ga., April 2-3, 1959, held at Heart of Atlanta Motel (*left to right*): E. R. Davis, Duke Power Company, Charlotte, N. C.; W. S. Hines, Westinghouse Electric Corporation, Atlanta, Ga.; R. B. Flowers, General Electric Company, Atlanta, Ga.; C. E. Robinson, Reliance Electric & Engineering Co., Cleveland, Ohio; J. W. Ward, Avondale Mills, Sylacauga, Ala.; Swaffield Cowan, Factory Insurance Association, Charlotte, N. C.; B. R. Stratton, Cutler Hammer, Inc., Atlanta, Ga.; R. H. Clark, The Warner and Swasey Co., Cleveland, Ohio; R. I. Uhl, West Point Manufacturing Co., Langdale, Ala.; L. C. Moore, Westinghouse Electric Corporation, Atlanta, Ga.; J. D. McConnell, Southern Electric Equipment Co., Charlotte, N. C.; B. R. Becker, Louis Allis Co., Milwaukee, Wis.; R. R. Prechter, General Electric Company, Atlanta, Ga., R. E. Parker, General Electric Company, Charlotte, N. C.; H. S. Colbath, Bibb Manufacturing Co., Macon, Ga.; G. U. Messner, Micro Switch Division, Chattanooga, Tenn.; J. W. Nims, Chemstrand Corp., Pensacola, Fla.; and C. D. Beck, General Electric Company, Schenectady, N. Y.

Pittsburgh Section AIEE

THE RECENT ANNUAL DINNER of the Pittsburgh Section climaxed an all day Student Program. Students from Carnegie Institute of Technology, University of Pittsburgh, Pennsylvania State University, and West Virginia University participated. Pictured (*left to right*) are: Prof. M. J. Smith, chairman of Student Activities; Dr. Eric Walker, president of Pennsylvania State University, guest speaker; W. R. Harris, chairman, Pittsburgh Section; and L. W. Tarn, incoming chairman Pittsburgh Section for 1960.

Photo by Syd Steen

HUGO AMELIO, *(second from left)* exhibit manager for U.S. Atomic Energy Commission's display "You and the Atom," welcomes B. L. England, *(second from right)*, chairman of the board of Atlantic City Electric Company, to the exhibit on display April 28-May 6 in the auditorium of the Jefferson Hotel, Atlantic City, N.J. Pictured with them are R. C. R. Schulze *(left)* and E. J. Brown *(right)*, Atlantic City Electric Company employees and members of the Atlantic City Division, Philadelphia Section of AIEE, local sponsors of the display which depicted the peaceful use of the atom.

AEC Exhibit "You and the Atom"

The scene of America's first National Youth Conference on "You and the Atom" took place in Atlantic City, N. J. The Conference was sponsored by 70 electric utilities located in 36 different states. It was conducted by several of America's leading scientists, physicists, and atom experts. More than 700 high school senior and junior science students and science teachers from all parts of the United States participated in the 2-day workshop and panel discussions on the peaceful use of the atom.

In connection with this National Youth Conference, "You and the Atom," an exposition by the Atomic Energy Commission (AEC), was sponsored by the Atlantic City Division of the AIEE Philadelphia Section, under the leadership of E. J. Brown, chairman.

In addition to the Conference delegates, the public was invited to see the giant display of progress in the peaceful use of the atom. The exhibit occupied 5,000 square feet of floor space and was composed of 62 panels along with models and other objects concerning the peacetime program of the AEC. (See "Only Museum of Its Kind" on p. 781, this issue.)

Tom MacCauley, chairman of "Meet the Engineer" Radio Committee of the Philadelphia Section, has made arrangements for the broadcasting of some of the panel sessions which were recorded, including the following: "How We Are Using the Atom," "Industrial Uses of the Atom," C. E. Robbins, executive manager, Atomic Industrial Forum, Inc.; "Agricultural Uses of the Atom," Dr. C. L. Comar, director of Radiation Biology, Cornell University; "Medical Uses of the Atom," Dr. John Laughlin, chief, Division of Physics, Sloan-Kettering Institute of Cancer. These presentations are made up into two 15-minute radio broadcasts, which will be presented on the program "Meet the Engineer," over station WFLM, Philadelphia, Pa., on July 11 and 25, 12:45 to 1:00 p.m.

Conference on Magnetism and Magnetic Materials

The 5th Conference on Magnetism and Magnetic Materials will be held in Detroit, Mich., November 16-19, 1959, at the Sheraton-Cadillac Hotel. This Conference is sponsored by the AIEE in co-operation with the Office of Naval Research, the Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Physical Society, and the Institute of Radio Engineers.

Abstracts should be received by J. E. Goldman, Scientific Laboratory, Ford Motor Company, P.O. Box 2053, Dearborn, Mich., by August 25. Instructions to authors as well as further conference details can be obtained from D. M. Grimes, Department of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

Technical Periodicals

The technical periodicals, *Communication and Electronics, Applications and Industry*, and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis issued six times a year. Members may receive one subscription to any *one* of the technical periodicals for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers, and subscription agencies.

AIEE FELLOWS ELECTED

Board of Directors Meeting, April 23, 1959

Ivan Lester Bateman (M '48), chief electrical engineer and assistant manager, Department of Water and Power of the City of Los Angeles, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development and operation of a major metropolitan utility." Mr. Bateman was born in Waverly, Ill., on April 29, 1900. During World War I, he served as an observer in France with the Army Air Force, 34th Air Squadron, for a year. Following his discharge, he worked as a lineman helper and lineman for an electric utility in Peoria, Ill. After moving to Los Angeles. Mr. Bateman entered the University of Southern California (USC) and took a night job as power station operator with the Department of Water and Power. He was graduated from USC in 1928 with an electrical engineering degree and soon after took a position in the Inspection Engineering Division of the Bell Telephone Laboratories in New York, N. Y. He returned to the Department the following year, 1929, as a communication engineer. In 1949, Mr. Bateman was appointed assistant engineer of distribution; in 1949, electrical engineer in charge of Operation and Maintenance Division; in 1952, assistant chief electrical engineer; and in 1953, he became chief electrical engineer and assistant manager. Mr. Bateman is a member of the International Conference on Large Electric High Tension Systems (CIGRE), a registered professional engineer in the State of California; a member and past president of the Electric Club of Los Angeles; a member of Tau Beta Pi and Eta Kappa Nu. He was the Department's representative on the National

Electric Utility Defense Advisory Council during 1951, 1952, and 1953.

Delmar Dudley Chase (AM '29, M '39), general superintendent of electrcial system. The Detroit Edison Company, Detroit, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the planning and performance of a large power system and to the design of large two-winding turbine generators." Mr. Chase was born in Winfield, Kans., on April 22, 1898. He was graduated from Kansas State College in 1923 with a B.S.M.E. degree and was employed by the General Electric Company in Schenectady, N. Y., as a test engineer. He was an engineer in the turbine generator design department in 1925, and from 1926 until 1941 he was an application engineer in the central station department. He was employed by the Detroit Edison Company as a bulk power engineer in 1941, becoming assistant to the superintendent of electrical system in 1945 and assistant general superintendent of electrical system in 1953. He was advanced to his present position of general superintendent of electrical system in 1954. Mr. Chase is the inventor of the double-winding generator for which he received the Coffin Award from the General Electric Company in 1929. He is a registered professional engineer in Michigan, a member of the Engineering Society of Detroit, and the International Conference on Large Electric Systems (CIGRE). Mr. Chase has served on the AIEE Membership Committee (1947-48).

John Ruskin Coffin (AM '24, M '31), senior vice-president, Jackson & Moreland, Inc., Boston, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to engineering management and economic evaluation and design of large power projects." Mr. Coffin was born February 14, 1895, in Medford, Mass. In 1916, he received the A.B. degree *cum laude* from Harvard College, where he became a member of Phi Beta Kappa. He also graduated from Massachusetts Institute of Technology with a B.S. degree in E.E. He then returned to MIT as a cadet in the Army Aviation Ground School. Following his discharge in 1919, he was employed by the American Telephone & Telegraph Company and then in the Foreign Department of the National Bank of Commerce in New York, N. Y. In 1921, he became associated with Jackson & Moreland, where he is now a senior vice-president, with general supervision of about 400 engineers and draftsmen. His 37 years' experience with Jackson & Moreland has covered most phases of power system economics and design, as well as numerous projects in other fields. Typical projects for which he was directly responsible include, in the field of power generation: an economic study to determine optimum location and size for the generating unit which became Boston Edison's 125 megawatt Mystic No. 4; in power distribution: a new 13.8-kv distribution system for Taunton, Mass., and a study of electrical switching facilities in a large paper mill; in railroad electrification: power system design for the Hoboken Suburban Electrification of the Lackawanna; in communication: a two-way radio system for Boston police cars and revamping of the patrol box system. Mr. Coffin is a director and formerly a vice-president of Atomic Power Development Associates, Inc.

Elson-Alexandre

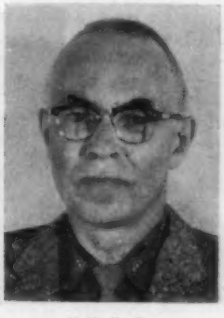
I. L. Bateman

D. D. Chase

James Potter Dallas (M '44), supervisor, Equipment Laboratory, Hughes Tool Company–Aircraft Division (formerly Hughes Aircraft Company), Culver City, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of electrical equipment for operation in the rigorous environment encountered by modern aircraft." Mr. Dallas was born in Charlestown, Wash., on December 2, 1904. He attended the University of Washington. He has been engaged in electrical design and equipment testing for the aircraft industry for 20 years, 18 years with the Hughes Companies (1941-59) and 2 years with the Lockheed Aircraft Company (1939-41). He is a member of The Advisory Staff for Aircraft Electric Systems, sponsored jointly by the Wright Air Development Center and the Bureau of Aeronautics since 1951; a member of the AIEE Air Transportation Committee since 1947; chairman of the AIEE Subcommittee on Dielectric Test Procedure, member of the West Coast Subcommittee of the AIEE Dielectrics Committee; member of the Society of Automotive Engineers A2 Aircraft and Missile Electrical Equipment Committee, and the A2Y Subcommittee on Electrical Systems and the A2R Subcommittee on Relays. Mr. Dallas is the author or co-author of 12 technical papers in publications such as *Electrical Engineering*, AIEE *Transactions, Electrical Manufacturing*, and *Air Transport*. Five of these technical papers won awards in the Los Angeles District Prize Paper Competitions, second prize 1948, second prize 1952, first prize 1954, and first and third prize 1955. He is a registered professional engineer in the State of California.

Raymond F. Guy (M '57), senior staff engineer, National Broadcasting Company (NBC), Inc., New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the technical development of radio and television network broadcasting." Mr. Guy was born in Hartford, Conn., on July 4, 1899. A radio amateur in 1911, he later became a ship radio officer with the Marconi Wireless Telegraph Company in 1916 and, subsequently, with Shipowners Radio Service and the Independent Wireless Telegraph Company. After World War I service in the U.S. Army in France, he entered Pratt Institute. Following graduation in 1921, he was employed by Westinghouse at the

J. R. Coffin



J. P. Dallas

R. F. Guy

world's second broadcasting station, WJZ, when it opened in 1921, as combined engineer and announcer. In 1924, he was drafted by the Radio Corporation of America (RCA) Research Laboratory for pioneering work in shortwave high-power broadcasting, network development, etc., and was responsible for the development of all broadcasting equipment used and sold by RCA. In 1928, he was one of the staff of nine men which undertook RCA's earliest television development. Transferring to NBC in 1929, he was for 27 years responsible for all planning and construction of transmitting facilities, frequency allocations, etc. Mr. Guy served as president of the Institute of Radio Engineers in 1950, treasurer in 1947, and a director for many years. He was president of the Broadcast Pioneers in 1955-56, was vice-president for a number of years, and is currently secretary. For many years he was chairman of the Engineering Advisory Committee of the National Association of Broadcasters and for years has been chairman of the Engineering Committee of the Voice of America and a member of the Industry Advisory Committee. He is a Fellow of the Radio Club of America and a member of the AIEE Television and Aural Broadcasting Committee (1956-59), American Standards Association Sectional Committee C63, Association of Federal Communications Consulting Engineers, three committees of the Electronic Industries Association, Radio and Television Executives Society, Society of Motion Picture and Television Engineers, and Television Pioneers. He is also first vice-president of the Veteran Wireless Operators Association and a director of the DeForest Pioneers.

Vincent John Hayes (AM '31, M '45), electrical engineer, The Connecticut Light & Power Company, Berlin, Conn., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to planning, designing, and construction of a state-wide power system." Mr. Hayes was born September 11, 1902, in Winsted, Conn. He graduated from Sheffield Scientific School (Yale) with a B.S. degree in E.E. in 1925 and joined the General Electric Company as test engineer. In 1926, he was employed by The Connecticut Light & Power Company and was assigned to work in their test department. He transferred to the engineering department in 1937 and became electrical engineer in 1950. Mr. Hayes pioneered in the application of reclosing to multiple terminal transmission lines. In connection with this work, he conducted a series of staged fault tests on the 115-kv system to investigate the characteristics of high-voltage arcs. He played a leading role in planning a unified transmission system for the three major utilities in the State of Connecticut, and has personally directed the electrical design of all recent generating units installed by The Connecticut Light & Power Company. He has been very active in AIEE Connecticut Section Committees for the past 25 years and served as chairman of the Connecticut Section in 1945-46. He was a member of the AIEE Switchgear Committee (1948-58), member of the AIEE Relays Committee (1947-55), special member of AIEE Insulated Conductors Committee (1957-date), member of the Edison Electric Institute (EEI) Transmission and Distribution Committee (1951-54), and is a member of the EEI Electrical Systems and Equipment Committee (1954-date). Mr. Hayes is an honorary member of Eta Kappa Nu and is a registered professional engineer in Connecticut.

George Edward Johnson (AM '13, M '37), consulting engineer, The Central Nebraska Public Power and Irrigation District, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to power systems for co-ordinated operations under public management." Mr. Johnson was born in Wymore, Nebr., on March 17, 1885. He attended Armour Institute of Technology, receiving degrees in both civil and electrical engineering in 1906. He was then employed by the Columbia Electrical Company of St. Joseph, Mo. In 1907, he opened a consulting engineer's office at Holton, Kans. From 1915 to 1923, he served as state engineer for the State of Nebraska. During this time, he started the original studies which were developed by the Platte Valley, Loup River, and The Central Nebraska Public Power and Irrigation Districts. In 1935, he was appointed chief engineer and general manager of The Central Nebraska Public Power and Irrigation District. When the three Nebraska hydroelectric districts entered into a joint agreement for operating the Nebraska Grid System, he was selected chairman of the Board of Managers, correlating the operations of the Nebraska Public Power System. In 1942, he organized Farm Crops Processing Corporation. From 1947 to 1950, he directed engineering and organization in setting up a department of water and power in Argentina. He returned to The Central Nebraska Public Power and Irrigation District as chief engineer in 1950. During 1957-59, he served as chief engineer and manager of the Steam Generating Division, in charge of engineering and construction of the Canaday Steam Plant. In January 1959, he was named consulting engineer. Mr. Johnson is a registered professional engineer and is a life member of the American Society of Civil Engineers.

Edwin Frank Kulikowski (AM '37, M '47), head, Data Processing Branch, U. S. Naval Research Laboratory (NRL), Washington, D. C., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the application of electronics to military uses, particularly to automatic processing of combat data." Mr. Kulikowski was born in Forest City, Pa., on January 13, 1910. He received the B.S. degree in E.E. from Union College, Schenectady, N. Y., in 1932. Under a Royall Victor Fellowship, he attended Stanford University during 1934-36 and earned the degree of electrical engineer in 1936. He was employed as a radio engineer by Jensen Radio Manufacturing Company during 1936-37, and by the Zenith Radio Corporation from 1937 to 1941. Since 1941, he has been engaged as an electronic scientist in the field of electronic systems at the NRL, and is at present head of the Data Processing Branch. Mr. Kulikowski is a registered professional engineer in the District of Columbia and holds two U.S. patents. He is a senior member of the Institute of Radio Engineers, and a member of the American Physical Society. In 1947, he was awarded the U. S. Navy Meritorious Civilian Award for participation in the development of electronic countermeasures equipment during World War II. Mr. Kulikowski has also served in the following capacities: as member, Subpanel on Information Centers and Nets, Electronics Committee, Research and Development Board, National Military Establishment, 1948-49; as chairman, Working Group on Displays, on the aforementioned subpanel, 1948-49; as NRL and BuShips consultant to Commander Submarine Forces Pacific, Hawaii, 1945; as consultant, Weapon Systems Evaluation Group, Joint Chiefs of Staff, Office of the Secretary Department of Defense, 1951; as NRL Representative at British Admiralty, U.K., 1951 and 1956.

Arthur Barnard Poole (AM '28, M '35),

V. J. Hayes

G. E. Johnson

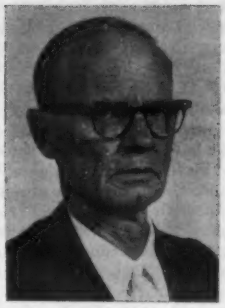
E. F. Kulikowski

Rubens Studios

A. B. Poole

president, The Mitrametric Company, Harwinton, Conn., and consulting engineer, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to creative design and manufacture of refined timing mechanisms by electrical means." Mr. Poole was born in Wheeling, W. Va., on November 6, 1905. He received the degree of E.E. from Cornell University in 1926. Upon graduation, he joined Gibbs and Hill, Inc., and worked on the Long Island–New York Connecting Railroad electrification. Later, he worked on electrolysis survey for the Manufacturers Light and Heat Company of Pittsburgh, Pa. In 1928, he joined the Morse Products Company in Ithaca, N. Y., to engage in design work on electric clocks. He joined the E. Ingraham Clock Company in Bristol, Conn., in 1930. During the next 12 years, he was in charge of design and production of electric clocks and electric timing devices and developed automatic electronic equipment for the timing of balance wheels in clocks and watches and several types of synchronous timing motors. When the war started, he was placed in charge of the production of the mechanical time fuse program at the Ingraham Company. In 1942, he joined the William L. Gilbert Clock Company to set up an electrical division, first for the production of electric test instruments and precision resistors and, after the war ended, synchronous timing motors, electric clocks, and synchronous timing devices of various kinds. In 1950, he joined the Hayden Manufacturing Company as a consultant on synchronous timing motor problems. In 1946, he founded the Mitrametric Company to promote some new ideas he had worked out on tooling for precision stamped gears and in 1954, The Altair Corporation, for the production of screw machine parts and electric timing devices. He has been granted 39 patents, mainly on synchronous timing motors and timing devices for automatic control. He has presented papers to the Connecticut Section on synchronous timing motors and also has written articles on this subject for various trade journals.

Robert Lackey Pulley (M '42), vice-president and operating manager, Gulf Company, Pensacola, Fla., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design, operation, and management of electric power systems." Mr. Pulley was born in Huntsville, Ala., on October 19, 1901. He attended Alabama Polytechnic Institute, graduating in 1922 with a B.S. degree in E.E. He began his utility career immediately after graduation by working as an apprentice engineer for the Alabama Power Company, Northern Division, at Huntsville, Ala. In 1923, he was promoted to office engineer responsible for engineering of general distribution system improvements, changeover of the Huntsville distribution system from 2.3-kv delta to 4-kv Y, and appraisal of distribution systems being acquired by the company. In 1925, he joined Gulf Power Company, a newly organized company operating in West Florida, as engineer. In 1935, he was promoted to chief engineer; in 1947, he was named operating manager; and in 1951, he was made a vice-president of the company. He has had responsible charge of design, engineering, planning,



R. L. Pulley

J. G. Trump

and supervision of the interconnection of the numerous small isolated distribution systems in West Florida into a completely integrated system complete with modern high-voltage transmission lines, substations, and generating plants. Mr. Pulley is a member of the Engineering and Operating Section of the Southeastern Electric Exchange, member of the Florida Engineering Society, and a registered professional engineer in the State of Florida. He assisted in the organization of the Mobile-Pensacola Subsection of AIEE (now Gulf Coast Section) and also served as chairman of the group.

John G. Trump (AM '31, M '48), professor of electrical engineering, High-Voltage Research Laboratory, Massachusetts Institute of Technology (MIT), Cambridge, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of high-voltage engineering, particularly supervoltage X rays." Dr. Trump was born August 21, 1907, in New York City. He received the E.E. degree from Polytechnic Institute of Brooklyn in 1929, the M.A. (physics) from Columbia University in 1931, and the D.Sc. from MIT in 1933. Dr. Trump has served in his present position at MIT since 1952. He has been chairman and technical director of High Voltage Engineering Corporation, Burlington, Mass., since 1947. From 1942 to 1944, he was secretary of the Microwave Committee of the National Defense Research Committee and later he was appointed director of the British branch of the Radiation Laboratory. For his war work he was decorated with His Majesty's Medal (England) for his assistance to the U.S. Air Force and for his co-operation with Britain in the field of radar. In 1948, he was awarded the President's Certificate of Merit. Dr. Trump is the author of papers in fields of high-voltage research, including generation of constant potentials in the range from 1-10 million volts; insulating properties of compressed gases and high vacuum; the acceleration of charged particles to high energies for nuclear research; physical properties of supervoltage X rays and cathode rays; application of supervoltage X rays and electrons to the treatment of malignant disease and the sterilization of biologicals and food materials. He is co-author of medical papers on the clinical use of X rays and electrons and the treatment of malignant diseases. Dr. Trump is a member of the American Nuclear Society, American Physical Society, New England Roentgen Ray Society, American Radium Society, and American Academy of Arts and Sciences. He served on the AIEE Nucleonics Committee (1948-58).

AIEE PERSONALITIES

G. E. Adams (AM '52, M '59), and **R. J. Noorda** (AM '52) have been appointed operations analysts to the staff of General Electric Company's Phoenix, Ariz., computer department. Both men were previously with the company's Apparatus Sales Division in Schenectady, N. Y.

A. C. Abbott (M '46), vice-president, distribution, The Shawinigan Water and Power Company, Montreal, Que., Canada, and **W. R. Wray** (M '42, F '53), vice-president and chief engineer, have been appointed vice-presidents with broader responsibilities in the company's affairs. **J. A. Smith** (AM '44, M '53), manager, production and plant department, has been named assistant vice-president, production and transmission. Mr. Wray, who served as vice-president for AIEE District No. 10 (1951-53), has been a member of the following Institute Committees: Power Generation (1945-46), Membership (1947-49), System Engineering (1951-53), and Administration Department (1956-57).

C. S. Allen (AM '31, M '37) has been appointed director of engineering for The Electric Auto-Lite Company's Electrical Products Group. Mr. Allen will direct the group's expanded engineering program currently under way in the Toledo, Ohio, and Syracuse, N. Y., facilities.

K. J. Bondeson (AM '58) has been named assistant engineer in the Allis-Chalmers Manufacturing Company Power Equipment Division. Mr. Bondeson is an electrical engineering graduate of the University of Maine.

G. S. Brown (AM '33, F '50), head of the department of electrical engineering, Massachusetts Institute of Technology (MIT), has been appointed dean of the MIT School of Engineering. Dr. Brown is internationally known for his contributions to education and for his research and leadership in the field of automatic control systems. He has been on the teaching staff at MIT since 1931, serving the entire time in the department of electrical engineering, and has done extensive Government consulting. He is a fellow of the American Academy of Arts and Sciences and the Institute of Radio Engineers, and a member of the American Society for Engineering Education, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. Dr. Brown has served on the following AIEE Committees: Industrial Control (1946-48, 1949-52); Instruments and Measurements (1947-48, 1949-50); Feedback Control Systems (1949-58, chairman 1949-50); Technical Program (1949-50); Standards (1949-52); Industry Co-ordinating (1949-50); Award of Institute Prizes (1950-52); Board of Examiners (1954-57); and Education (1958-59).

C. W. Calvert (AM '50) has been appointed to the Electrical Design Section of the SUBROC anti-submarine missile project at Goodyear Aircraft Corporation. Prior to joining Goodyear Aircraft in January, he had been employed since 1950 by Bell Aircraft Corporation, Buffalo, N. Y.

W. S. Caldwell (AM '48, M '55), consulting engineer, Charles T. Main, Inc., Boston, Mass., has been appointed to a newly created position of utility apparatus engineer for the I-T-E Circuit Breaker Company's southern sales region.

R. S. Caruthers (M '47) has been elected vice-president and technical director of ITT Laboratories, Nutley, N. J., research division of International Telephone and Telegraph Corporation. Mr. Caruthers is former deputy director of research and engineering for the parent corporation. He has been a member of the AIEE Radio Communication Systems Committee (1953-58) and Wire Communication Systems Committee (1954-59).

A. G. Clavier (M '48, F '53), who retired in March as vice-president and technical director of ITT Laboratories, Nutley, N. J., has been appointed scientific advisor to the Laboratories president, Henri Busignies. Mr. Clavier, who is celebrating his 30th anniversary with the ITT System, has specialized in the development of advanced radio communication techniques, notably in the microwave science employed by radar and television. Mr. Clavier is a *membre laureat* of the Societé Francaise des Electriciens and president of the American section of the Societé des Ingenieurs Civils de France. He is a member of both the Societé des Radioelectriciens and Institution of Electrical Engineers, and a fellow of the Institute of Radio Engineers. Mr. Clavier has served on the following AIEE Committees: Special Communication Applications (1951-52), Radio Communication Systems (1953-55), and Board of Examiners (1956-59).

J. B. Clark (AM '46) has been elected executive vice-president of ESB International Corp., New York, N. Y., and ESBIC Corporation, S. A., Panama City, Panama, wholly owned subsidiaries of The Electric Storage Battery Company.

T. A. Combellick (AM '56), manager of Lenkurt Electric Company's office in Washington, D. C., has been promoted to chief engineer in the Military Division of the company. Mr. Combellick is a member of the AIEE Radio Communication Systems Committee (1956-59).

E. D. Councill (AM '56) has been promoted to staff engineer in the standard memory design department of the IBM Product Development Laboratory at Poughkeepsie, N. Y., where he is working on the design and development of high-speed large-scale magnetic core memories for advanced data processing systems.

C. E. Dean (AM '23, F '55, Member for Life), consulting engineer of Hazeltine Research Corporation, a subsidiary of Hazeltine Corporation, has received a national award for his outstanding service to the Institute of Radio Engineers (IRE) Professional Group on Broadcasting and Television Receivers. Dr. Dean, who recently celebrated his 30th anniversary as a Hazeltine engineer, has devoted his energies to electronic industry and engineering society activities for many years. In addition to holding degrees from Harvard, Columbia, and Johns Hopkins Universities, Dr. Dean has been a licensed engineer for the past 25 years. He is a fellow of the Radio Club of America, a senior member of the IRE, and an active member of the Society of Motion Picture and Television Engineers. Dr. Dean has served on the following AIEE Committees: Publicity (1942-44, 1954-58); Communication (1948-49); Television and Aural Broadcasting Systems (1956-59, chairman 1952-54); Communication Division (1952-59); Award of Institute Prizes (1954-57); Standards (1956-59); Special Publications (chairman 1957-58); and Periodicals and Transactions (1957-58).

David Dibner (AM '53), has been appointed to the newly created post of commercial products manager of the Omaton Division, Burndy Corporation. Joining Burndy in 1952 as an engineering trainee, Mr. Dibner served in various development engineering capacities, as assistant manager of the company's Milford, Conn., plant, and as product promotion manager of the Omaton Division.

E. J. Diebold (AM '51, M '56), director of heavy-duty product department International Rectifier Corp., has been appointed technical manager of the Industrial Rectifier Division of Perkin Engineering Corp., El Segundo, Calif. Mr. Diebold holds 15 U. S. patents, with 25 more pending. He is a member of the AIEE Industrial Power Systems Committee (1955-59) and Semiconductor Metallic Rectifiers Committee (1958-59).

H. E. Edgerton (AM '27, F '46), chairman of the board, Edgerton, Germeshausen & Grier, has been named New England Engineer of the Year. Dr. Edgerton, inventor of electronic flash photographic equipment and pioneer in stroboscopic techniques, was cited at a luncheon meeting of the Engineering Societies of New England held at Harvard University as a feature of National Engineers' Week. Dr. Edgerton has been a professor at Massachusetts Institute of Technology since 1948. He is a fellow of the Institute of Radio Engineers, and a member of the American Academy of Arts and Sciences, The Society of Photographic Engineers, the International Photographic Society of America, Sigma Xi, Sigma Tau, and Eta Kapp Nu. Dr. Edgerton served on the AIEE Electrical Machinery Committee (1931-35) and Research Committee (1947-55).

R. F. Garbarini (AM '41, M '53), has been appointed director of engineering and sales in Sperry Gyroscope Company's Air Armament Division. He served previously as an engineering manager of the Division's Hustler group, which is responsible for development and production of the navigation system for the USAF's *B-58* supersonic bomber. **R. L. Wendt** (AM '43, M '50) has been appointed manager, sales and subcontracts, Hustler.

K. E. Glover (AM '51, M '58), business planning and marketing specialist, General Electric Company, Plainville, Conn., has been appointed manager of process components marketing, Sanders Associates, Inc., Nashua, N. H. Mr. Glover will direct the marketing expansion of Sanders' newly formed Flexprint Products Division.

J. E. Goldman (AFFIL '56), manager of the physics and chemistry departments of Ford Motor Company's Scientific Laboratory, Dearborn, Mich., has been selected as Visiting Webster Professor of electrical engineering at Massachusetts Institute of Technology. Mr. Goldman is a member of the AIEE Basic Sciences Committee (1956-59).

G. W. Griffin, Jr. (AM '50), vice-president in charge of public relations, Sylvania Electric Products, Inc., has been elected a vice-president of General Telephone & Electronics Corporation. Mr. Griffin will guide the public relations function of the firm. He was a member of the AIEE Public Relations Committee (1955-57).

C. B. Gwyn, Jr. (M '42), product specialist and technical advisor, General Plate Division, Metals & Controls Corp., Attleboro, Mass., has been named special projects engineer, Gibson Electric Company. At the company's home plant in Delmont, Pa., Mr. Gwyn will be responsible for technical liaison with engineering, manufacturing, and sales.

Herbert Hellerman (AM '52), associate professor of electrical engineering, University of Delaware, has joined the research staff of International Business Machines Corporation as a staff engineer at the Yorktown, N. Y., research laboratory. He is a member of the AIEE Electronics Committee (1957-59).

Alexander Kuys (AM '58), of the General Electric Locomotive and Car Equipment Plant, Erie, Pa., has been appointed to the engineering staff of The Ohio Carbon Co., Cleveland, Ohio.

R. V. McFadden (AM '55) has been promoted to project engineer in the Product Enginering *700* Series DPM Department at the IBM Product Development Laboratory, Poughkeepsie, N. Y.

J. W. McGarity (AFFIL '56), sales engineer, The Fred W. Kiemle, Co., Toledo, Ohio, has been promoted to sales manager of the motor control department of the firm.

W. E. Montgomery (AM '35, M '43), general manager of operations for Southern California Edison Company, has been elected a vice-president. Mr. Montgomery will continue in charge of the company's operating department activities throughout the Edison system. He served on the AIEE System Engineering Committee (1949-52).

K. M. Patterson (AM '49) has been promoted to a newly created position as manager of headquarters sales departments for the Westinghouse Electric Corporation's Apparatus Division in East Pittsburgh, Pa. Succeeding Mr. Patterson in his former position as manager of the division's industrial sales department is **C. E. Hammond** (AM '46, M '57), who was formerly assistant manager of the division's South Pacific district in Los Angeles, Calif.

G. E. Pihl (AM '45), vice-president in charge of engineering, Acton Laboratories, Inc., subsidiary of Technology Instrument Corporation (TIC), has been named vice-president in charge of engineering of TIC and all subsidiaries.

Albert Preisman (M '41), has resigned as vice-president in charge of engineering of Capitol Radio Engineering Institute, which he joined in 1943. Mr. Preisman intends to expand his consulting electronic engineering practice in Silver Spring, Md., particularly in the fields of patent litigation and the preparation and writing of engineering reports.

H. L. Rusch (AM '24), vice-president, Opinion Research Corporation, Princeton, N. J., received a distinguished service citation from the University of Wisconsin, Madison, Wis., on May 1, 1959. Mr. Rusch was the principal speaker of the evening, discussing the subject of "An Engineer Tackles Some Human Relations Problems."

A. J. Sanchirico (AM '50, M '57) has been advanced to senior engineer in charge of general development for the IBM Special Engineering Products Division (SEPD) in Poughkeepsie, N. Y. Mr. Sanchirico was assigned to SEPD in 1957 as a development engineer, acting as manager of source data systems and, later, of general development. **R. N. Sweetland** (AM '46, M '54), has been advanced to functional manager of product design and fabrication in the SEPD. He is in charge of design engineering, product control, records, and fabrication.

G. L. Schlaepfer (AM '24), co-ordinator of international co-operation programs for Detroit Edison Company, has won the company's Alex Dow Award for his outstanding work in planning and carrying out special programs in which foreign visitors have had the opportunity to study Detroit's industrial accomplishments and, at the same time, gain better understanding of life in America.

R. B. Stryker (AM '51) has been promoted to the position of advisory engineer in the Magnetic tape department of the IBM Product Development Laboratory at Poughkeepsie, N. Y., where he is providing technical assistance to the manager of that area.

G. E. Warner (AM '58), senior sales engineer for process computers at General Electric Company's computer department, Phoenix, Ariz., has been appointed sales manager of process computers.

W. T. Wessels (AM '37, M '41), has been appointed assistant to the vice-president of Engineers, Inc., Consulting Engineers, Newark, N. J. Mr. Wessels is currently president of the Professional Engineers of Union County, and a member of the New Jersey and National Societies of Professional Engineers.

D. C. Whitmore (AM '52) has been promoted to staff engineer in the diagnostic engineering department of the IBM Product Development Laboratory at Poughkeepsie, N. Y., where he is engaged in the study of methods to further increase the maintainability and serviceability of data processing systems.

B. T. Bartlett (M '58), sales engineer, Cincinnati, Ohio, office of The Okonite Company, has been appointed district manager of the company's Syracuse, N.Y., office.

C. H. Dunn (AM '43, M '58), professor of electrical engineering, Rensselaer Polytechnic Institute, Troy, N. Y., has been appointed associate head of the department of electrical engineering.

P. F. Eckelman (AM '53), has been promoted to development engineer in the Bank Systems Development Department of the International Business Machines Corporation Product Development Laboratory, Poughkeepsie, N. Y., where he is in charge of electrical and electronic design of the Bank System, Magnetic Character Sensing sorter—reader and sorter—reader to *650* converter.

C. L. Greenley (AM '51), regional manager, New Jersey Territory, Rumsey Electric Company, has been appointed commercial vice-president and member of the management committee of the company. Mr. Greenley will continue to handle the New Jersey Territory, but will take on additional duties in the management of the company.

D. E. Farmer (AM '56) and **E. M. Gore** (AM '50) have been appointed to positions of engineering section head (Communication Division), American Electronic Laboratories, Inc., Philadelphia, Pa.

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S. A. Kroll (AM '30), has resigned as vice-president of Taller & Cooper, Inc., and has opened his own consulting engineering office in Brooklyn, N. Y.

C. B. Kutschback (AM '55), manager, Power Stations Section, Duquesne Light Company, has been appointed general superintendent of construction for the company.

H. J. Lewenstein (AM '50), has been promoted to applications engineering manager in the Commercial Products Division of Lenkurt Electric Co., San Carlos, Calif.

C. W. Martel (AM '46), manager, technical information service, Raytheon Manufacturing Company, has been named advertising and sales promotion manager for the Semiconductor Division of Raytheon.

R. L. Moubray (AM '50), eastern district sales manager for G. H. Leland, Inc., was appointed western regional sales manager.

R. D. Okerberg (AM '53) has been promoted to chief engineer of electrical apparatus by Hubbard and Company, Chicago, Ill. He will operate out of the new Hubbard electrical research and development laboratory in McCook, Ill.

R. M. Waggoner (AM '44, M '57), will take over the position he formerly occupied as vice president in charge of Hubbard and Company, West Coast operations. During the past 2 years, Mr. Waggoner has been active in effecting the consolidation of the Pittsburgh and Chicago pole line hardware plants, the building and staffing of the Electrical Research Laboratory, and the moving of Hubbard and Company's executive offices to Chicago.

C. A. Walter (AM '52) has been appointed manager of applications engineering for Granger Associates, Palo Alto, Calif. Mr. Walter is a member of the AIEE Wire Communication Systems Committee (1956-59).

OBITUARIES

Donald A. Quarles (AM '23, M '29, F '41, HM '56), Deputy Secretary of Defense, and past-president of the AIEE, 1952-53, died recently. Mr. Quarles was born in Van Buren, Ark., on July 30, 1894. He was graduated from Yale University in 1916 with a B.A. degree. During World War I, he served for 2 years in the U. S. Army, being discharged with the rank of Captain. In 1919, he joined the Western Electric Company engineering department which, in 1925, became the Bell Telephone Laboratories, Inc. Mr. Quarles became a vice-president of the Laboratories in 1947. He also served as president of Sandia Corporation and vice-president of Western Electric Company, Inc. He was appointed

Official U. S. Air Force Photo
Donald A. Quarles

Assistant Secretary of Defense for Research and Development in September 1953 and assumed the position of Air Force Secretary in August 1955. He was named Deputy Secretary of Defense in 1957. Mr. Quarles was a member of the American Physical Society, the Institute of Radio Engineers, the Yale Engineering Association, the American Association for the Advancement of Science, and the Telephone Pioneers of America. He received an honorory doctor of engineering degree from New York University's College of Engineering in 1955. Mr. Quarles had served as a director of the AIEE, 1944-48, and on numerous Institute Committees, including the following: Finance (1944-48, chairman 1946-48); Edison Medal (1945-47, 1953-55); Electronics (1945-47); Instruments and Measurements (1945-46); Board of Trustees, AIEE Retirement System (1945-48); Planning and Co-ordination (1946-48); Headquarters (1946-48); Lamme Medal (1947-50); Management (1948-52); Board of Trustees, United Engineering Trustees, Inc. (1948-54); Executive (1952-54); and John Fritz Medal (1953-57).

Earl John Bates (AM '43, M '47), foreman, electrical testing department, National Cash Register Company, Dayton, Ohio, died recently at the age of 64. Mr. Bates was born May 7, 1894, in Youngstown, Ohio. He had been associated with the National Cash Register Company for 45 years. Active in civic affairs, Mr. Bates was chairman of the Oakwood city council. He was a member of the AIEE Electric Heating Committee (1950-59), and had been serving as secretary of the Committee.

Herbert Hughes Cox (AM '08, M '27, F '53, Member for Life), retired, Department of Water and Power, Los Angeles, Calif., died recently. Mr. Cox was born in Central, Ind., on July 13, 1888. He had been a resident of California since 1897 and was actively associated with hydroelectric power development in the State for over half a century. He graduated from California Polytechnic Institute in 1906 with a degree in electrical mechanics. He worked as an operator for the Southern California Edison Company until 1922 when he became chief operator of receiving and distributing stations for the Department of Water and Power. At the time of his retirement in 1952, he was assistant electrical engineer in charge of operation. He served as chairman of the Los Angeles Section of the Institute in 1921-22.

William C. Dorn (AM '41), district sales manager, Moloney Electric Company, Naberth, Pa., died recently. Mr. Dorn was born April 20, 1901, in Philadelphia, Pa. He was educated in the Philadelphia public schools and the Franklin Institute Night School. He worked for I-T-E Circuit Breaker Company, Electric Power Equipment Co., and others, prior to becoming associated with Moloney Electric Company. Mr. Dorn was a member of the Engineers Club.

Charles Eugene Drennen (AM '09, M '13, Member for Life), retired electrical engineer, died recently at the age of 76. Mr. Drennen was born November 15, 1882, in Minneapolis, Minn. He attended Case School of Applied Science, Cleveland, Ohio, where he received the B.S. degree in 1904, and the E.E. degree in 1907. He was associated with several firms before joining Hendrie & Bolthoff Co., Denver, Colo., in 1908. He was employed there until his retirement in 1954.

Alfred O. Kenyon (AM '47), electrical engineering department, New York State Electric & Gas Corporation, Binghamton, N. Y., died recently. Mr. Kenyon was born July 12, 1901, near Oneonta, N. Y., and attended the University of Pennsylvania. After leaving school, he worked for several concerns in the Philadelphia area, among them the Philadelphia Transit Company. In 1929, he joined the New York State Electric & Gas Corporation at Oneonta, N. Y., as a rate engineer and assistant to a vice-president in rates and regulating matters. In 1939, he was transferred to the Ithaca office. In 1940, he transferred to the engineering department in Binghamton as a member of the drafting section, and in 1943 he became supervisor of the drafting room. Since that time he had held various positions in the electrical engineering department and most recently was working on substation design and layout. Mr. Kenyon had served as chairman of the Binghamton Area Subsection in 1955-56. He was also active in the Ithaca Section, having been chairman at the time of his death.

Charles K. Kahn (AM '52), engineer, Electric Distribution Division, New Orleans Public Service, Inc., New Orleans, La., died recently. Mr. Kahn was born August 4, 1903, in Grand Coteau, La. He received his B.E. degree in E.E. from Louisiana State University in 1926. He joined New Orleans Public Service, Inc., in 1927 and was continuously in their employ except for 4½ years during World War II in the Army, from which he was discharged with the rank of Major.

Louis F. Paret (AM '47), Westinghouse Electric Corporation, Richmond, Va., died recently. Mr. Paret was born May 10, 1902, in Philadelphia, Pa., and attended Johns Hopkins University. In 1922, he entered the Westinghouse Student Course in East Pittsburgh, Pa., and in 1923 he was appointed sales assistant in Baltimore, Md. He was transferred as salesman to Richmond in 1926, and to Norfolk in 1930. Mr. Paret was a secretary of the Richmond Subsection of the AIEE. He had been active in local AIEE affairs for many years.

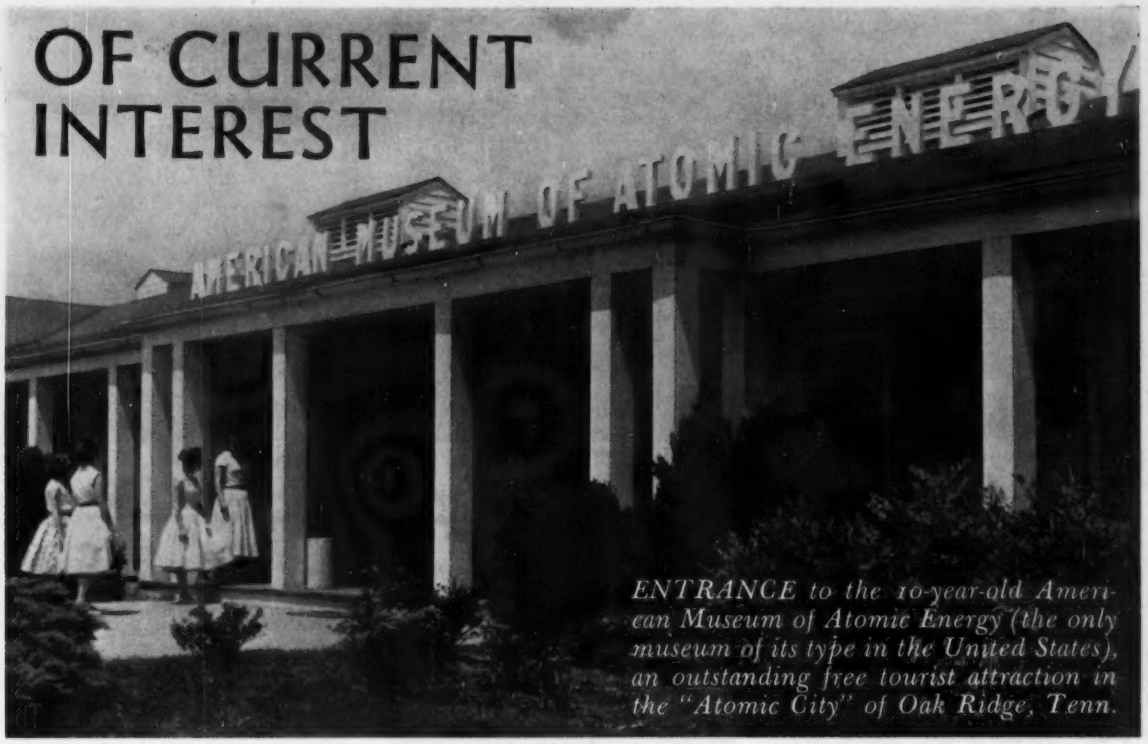
Charles L. Pillsbury (AM '97, M '14, Member for Life), of Wayzata, Minn., died recently at the age of 86. Mr. Pillsbury was born December 16, 1872. He received degrees in mechanical, electrical, civil, and chemical engineering from the University of Minnesota and Purdue University. Early in his career, Mr. Pillsbury served as instructor and consultant in the engineering department of the University of Minnesota. After being a member of the firm of Clausin, Burch and Pillsbury, he formed Charles L. Pillsbury Co., general consulting engineering business. He joined Munsingwear, Inc., in 1917 as an assistant to the president and consulting engineer. He was executive vice-president, secretary and treasurer, and member of the board of directors before his retirement in 1941. He returned to the firm in 1942 to handle the wage and salary stabilization law department, retiring again at the end of the war. Mr. Pillsbury was a member and past-president of the Engineers' Club of Minneapolis.

Vladimir K. Yagodkin (AM '25, M '41), electrical engineer, Tennessee Valley Authority, Knoxville, Tenn., died recently at the age of 64. Mr. Yagodkin was born in Russia on February 5, 1895. He was educated in Russia, where he graduated from the Petrograd Institute of Technology with a degree in E.E. in 1917. After graduation, he was employed in engineering work in Vladivostok until 1919 when he came to the United States. He attended Northwestern University for a short period. From 1920 to 1936, Mr. Yagodkin was associated in various electrical engineering capacities with several firms including Western Electric Company, Chicago, Ill.; Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.; Stone & Webster Engineering Corporation, Boston, Mass.; Pennsylvania Water and Power Company, Baltimore, Md.; and the Navy Department and other Government agencies in Washington, D. C. He spent 22 years in the Electrical Design Branch of the Tennessee Valley Authority. For the past 8 years, he held the position of staff electrical engineer on switchboard and wiring design.

Stephen J. Powers (M '51), retired, former vice-president in charge of research and engineering, International Telephone & Telegraph Company, died recently at the age of 54. Mr. Powers attended Cooper Union, where he received A.B. and electrical engineering degrees. During his career, he was associated with Western Electric Company, De Forest Radio Company, Grigsby-Grunow Company, and Federal Telegraph and Radio Corporation. He was a member of the Institute of Radio Engineers and the De Forest Pioneers.

Charles De Puy Robison (M '15, Member for Life), retired, of Omaha, Nebr., died recently. Mr. Robison was born March 4, 1877 in Geneva, N. Y. During his early engineering career, he was associated with the Gas Company at Geneva, N. Y.; Gas Company at Auburn, N. Y.; Rockland Electric Light & Power Company, Nyack, N. Y. In 1908, he became a member of the firm of Forstall and Robinson, Consulting Engineers, New York, N. Y.

OF CURRENT INTEREST



ENTRANCE to the 10-year-old American Museum of Atomic Energy (the only museum of its type in the United States), an outstanding free tourist attraction in the "Atomic City" of Oak Ridge, Tenn.

Only American Museum of Its Kind Explains the Atom in Layman's Terms

LEGENDARY Atomic City—Oak Ridge, Tenn.—opened its security gates on March 19, 1949, to give the general public its first opportunity to view the place where so much of the development work in releasing the tremendous force of the atom for mankind's use had been carried out in the utmost secrecy.

On that same day, 10 years ago, it also opened the doors to the American Museum of Atomic Energy—the only museum of its kind in the United States devoted to explaining this great force in simple, understandable terms for laymen.

During this past decade, over 750,000 persons from all parts of the world have visited the Museum at Oak Ridge. The facility has continuously been expanded and improved in its exhibits in order to keep the public acquainted with comprehensive, up-to-date information on the Nation's nuclear energy programs.

Another 26 million persons throughout the United States have had the story of the peaceful atom brought right to their home towns by the many traveling exhibits the Museum operates for the Atomic Energy Commission (AEC).

The Message

The "Atoms for Peace" message has been brought to large cities and rural communities, high schools and colleges, scientific meetings, fairs, and industrial conventions all over the Nation.

The American Museum of Atomic Energy is operated by the Museum Division of the Oak Ridge Institute of Nuclear Studies—a nonprofit educational corporation of 37 southern universities and colleges acting under direct contract with the AEC.

When the Commission decided to make the fenced-in town of Oak Ridge an "open city," while still keeping the vast atomic-energy plants behind security fences, the problem arose as to just what the public could see that would actually show them what nuclear energy was and how it worked. With the plant areas off-limits to visitors, there was little for them to see but a town of hastily built homes and structures—remarkable for the story behind it, but of little esthetic or educational value.

Coincidence provided a timely solution: An extensive atomic-energy exhibit had been prepared by AEC contractors for the New York City Golden Jubilee celebration in 1948. This exhibit had been dismantled, and was stored in a warehouse in Oak Ridge. It was suggested that the Commission establish a museum of atomic energy, utilizing the New York exhibit as a core, and the AEC asked the Oak Ridge Institute of Nuclear Studies (ORINS) whether it would be interested in assuming the responsibility for such a program.

The Institute, less than 3 years old at the time, was already carrying out several important educational programs for the Commission. A special advisory committee studied the proposal and made a favorable recommendation to the ORINS board of directors, which approved and activated the Museum program.

Given barely 5 weeks in which to remodel an abandoned cafeteria building to serve as a museum, gather a staff, and set up the exhibits, the Institute beat the

U.S. AEC Photo

STAFF MEMBERS of the American Museum of Atomic Energy check route for "You and the Atom" traveling exhibit prepared and operated by Museum Division for AEC.

U.S. AEC Photo

LOCATIONS of major radioactive ore deposits throughout the world are shown on Museum map being studied by visitors.

U.S. AEC Photo

STUDENT VISITORS see exhibit in Medical Room of American Museum of Atomic Energy demonstrating uses of radioisotopes in medicine.

deadline. When the gates of the city were opened on March 19, 1949, one of the main attractions that drew the attention of the "outsiders" was the American Museum of Atomic Energy—now an outstanding tourist attraction in the South for thousands of visitors each year.

The establishment of the Museum was only the beginning of AEC's program of keeping the general public abreast, through the media of exhibits, of progress in turning the new force of nuclear energy to peaceful uses. In 1951, traveling exhibits were transferred from Brookhaven National Laboratory. These exhibits were modified and expanded, and made available to colleges and universities. This was the first full-time traveling exhibit program.

In February 1956, the Commission announced a greatly expanded program and a new policy, making exhibits available free of charge to qualified local sponsors. At the end of that year the Museum Division was sending out 23 traveling units, 14 of which were accompanied by personnel. Today, the Museum Division operates some 28 units of five different types of exhibits for the Commission. These have been shown in 48 of the 50 states (inquiries have been received this year as to the possibility of showings in Alaska) and the District of Columbia.

Types of Exhibits

The exhibits are of various types to meet various needs. Largest in size are the jumbo "You and the Atom" exhibits, designed for showings at state fairs, conventions, and similar large convocations. Each of the two jumbo units takes up some 5,000 feet of display space, and consists of panel displays, spectator-participation displays, and demonstrations. Visitors to this exhibit receive a graphic explanation of the components of the atom, and become acquainted with the uses of nuclear energy and its products in research, medicine, agriculture, and industry. They see demonstrations of a nuclear-powered plant for the production of electricity, "mechanical hands" similiar to those used by researchers in handling materials inside heavily shielded "hot cells," and the process of producing radioisotopes in a reactor. A mannequin wears the "balloon suit" and other protective clothing used by personnel working in a radioactive environment.

Five mobile "Atoms for Peace" units are operated for the benefit of people in small towns and rural areas. These are walk-through trailer-type exhibits that can be parked in town squares or in front of local post offices, courthouses, or schools. The well-planned interior provides the visitor with a condensed version of the material in the larger exhibits, from the mining and processing of radioactive ores to an atomic powerhouse. Well over 1.5 million persons have walked through these mobile units since they first went on the road in 1956.

Several years before the recent wave of concern over the lack of adequate training of scientists in our schools and colleges swept the Nation, the Museum Division activated a special AEC exhibit designed specifically to arouse the interest of secondary-school students and teachers in the peacetime uses of atomic energy. Called "This Atomic World," six units of the exhibit are transported from school to school in panel trucks, with one of the Division's specially trained exhibits managers in charge.

Six units of "This Atomic World" are in use throughout the present school year, and showings are scheduled at summer camps, military installations, and recreational areas during the vacation months ahead. All in all, more than 2,000 schools throughout the Nation have been visited by units of "This Atomic World" since its inception in 1955.

Several units of other AEC exhibits are managed and scheduled by the Museum Division. Most of these are package exhibits, shipped to the sponsor by prepaid Railway Express, set up and displayed, and then shipped on to the next sponsor, without any ORINS personnel in attendance. These package exhibits range from a small, 10-foot-square display, intended primarily for use by libraries, to large, 18-panel displays for use at science fairs, at technical meetings, and similar gatherings.

All exhibits are provided to local sponsors for showings with no charge for the exhibit, its transportation, or the exhibits manager in the case of manned units. Also, admission is free to visitors of all traveling exhibits.

U.S. AEC Photo

MUSEUM EXHIBITS department staff artist at work on "Man and Energy" display being readied for 1959 exhibition.

New Displays

Currently, work is under way at the Museum to see that its 11th season is the best in its history. New exhibits are on the drawing boards and under construction in the Museum shops. Old displays have been completely redesigned and refurbished, and many other exhibits dealing with the peacetime applications of atomic energy have been installed. Visitors this summer will see a model of the *NS Savannah*, the nation's first nuclear propelled merchant vessel, and plans call for an exhibit on nuclear fusion to be set up later this year—the Museum's first display of this type. This summer will be the first heavy-visitor season since Museum admission charges were discontinued by the AEC last September.

As atomic energy becomes more and more a way of life, educational instruments such as the Museum and its traveling exhibits have the responsibility for instructing the public in a field that to millions is still a mysterious science.

Retransmission Station Handles 300 Radiophone Messages Over 30 Channels

COMMUNICATIONS play a major role in all phases of civilian and military activities. Progress made today in the development and integration into our armed forces of new weapons, equipment, tactics, techniques, etc., is the only assurance the United States has of keeping ahead of any potential enemy faced upon tomorrow's nuclear field of combat.

The U.S. Army Combat Development Experimentation Center (CDEC), charged with the mission of developing these requirements for our future Army, has for the past 3 years conducted extensive experimentation within its rugged field laboratory at the Hunter Liggett Military Reservation, located in California.

In order to facilitate accurate, timely reporting of scientific data to Experimentation Operations Center (EOC) of CDEC by data collectors in the field and also to provide EOC with facilities by which it may exercise maximum control over the data collectors, CDEC has installed a most unique radio communications network for future experimentation.

U.S. Army Photograph

TIMELY reporting of experimentation data to military and scientific analysts is accomplished by utilization of 300 portable radiophones. Efficiency is checked by plotting areas of Hunter Liggett Military Reservation covered in recent test.

This system, which was constructed and installed under U.S. Army contract by the Motorola Radio Corporation, will be for the exclusive use of the data-collector teams. The EOC, equipped with vast communications instrumentation, will act as the central control of all channels. Several miles from the EOC, perched upon a 2,450-foot peak, is the Site Alpha retransmission station. The site contains eight steel masts which rise 96 feet above the peak, and contain 40 antennas and one large microwave disk.

U.S. Army Photograph

VHF REPEATER UNIT is tuned at Site Alpha retransmission station, perched atop mountain, for unique data-collector communications system recently installed for CDEC experimentation. At present, it is capable of providing radiophone communications for 95 per cent of reservation field laboratory.

The station building has 30 radio repeater units which function automatically. Power for the system is derived from a 50-kw generator run by propane gas. In order to assure continuous operation at all times, two of these generators are on site. An automatic switchover system cuts in the standby generator if either one of the units should fail.

Future Meetings of Other Societies

Research & Development Management Seminar, July 5-10, Pennsylvania State University, University Park, Pa. Extension Conference Center, PSU, University Park, Pa.

Technical and Industrial Communications, 2nd Annual Institute, July 6-10, Colorado State University, Ft Collins, Colo. H. M. Weisman, CSU, Ft Collins, Colo.

American Water Works Association, Annual Conference, July 12-17, San Francisco, Calif. AWWA, 2 Park Ave, New York, N. Y.

Institute of Radio Engineers

4th Instrumentation Conference & Exhibit, Nov 9-11, Atlanta, Ga. *Final deadline for abstracts:* July 15. Earlier submission requested. Send to: W. B. Jones, Jr, Schl of Elec Engg, Georgia Institute of Technology, Atlanta 13, Ga.

1st National Ultrasonics Symposium, Aug 17, San Francisco, Calif. Vincent Salmon, Stanford Research Inst, Stanford, Calif.

WESCON, Aug 18-21, Cow Palace, San Francisco, Calif. WESCON HQ, 1435 LaCienega Blvd, Los Angeles, Calif.

Western Summer Radio-Television & Appliance Market, Division of Western Home Goods Market, July 20-24, Western Merchandise Mart, San Francisco, Calif.

Computers & Data Processing, 6th Annual Symposium, July 30-31, University of Denver, Stanley Hotel, Estes Park, Colo. W. H. Eichelberger, Denver Research Institute, U of D, Denver 10, Colo.

National Council of State Boards of Engineering Examiners, 38th Annual Meeting, Aug 19-22, Hotel Roanoke, Roanoke, Va. NCSBEE, Palmetto State Life Bldg, PO drawer 1404, Columbia, S. C.

AIME, Conference on Semiconductors, Institute of Metals Div, Aug 31-Sept 2, Statler Hotel, Boston, Mass. H. N. Appleton, AIME, 29 W 39 St, New York 18, N. Y.

Association for Computing Machinery, 14th Annual Meeting, Sep 1-3, MIT Cambridge, Mass. J. H. Wegstein, ACM Program Committee. NBS. Washington 25, D. C.

2nd Conference on Nuclear Radiation Effects on Semiconductor Devices, Materials, and Circuits, Sept 17-18, Western Union Auditorium, 60 Hudson St, New York, N. Y. Security clearance not required. B. Reich, Solid State Devices Branch, ECRD, U.S.A.S.R.D.L., Ft Monmouth, N. J.

Overseas

British Institution of Radio Engineers, Convention on TV Engineering in Science, Industry, and Broadcasting, July 1-5, U of Cambridge, England. BIRE, 9 Bedford Sq. London WC 1, England.

IEC, Annual Meeting July 1-10, Madrid, Spain. K. G. Ellsworth, American Standards Association, 70 E 45 St, New York 17, N. Y.

The Yugoslav Association for the Protection of Material, International Conference for Protection of Hydroelectric Power Plants and Equipment, Sept 14-16, Belgrade, Yugoslavia. Organizing Committee, above conference, Kneza Milosa St., No. 7/III, P.O. Box 771, Belgrade, Yugoslavia.

CIB Congress 1959, International Council for Building, Research Studies, and Documentation, Sept. 21-25, Rotterdam, The Netherlands. Congress Secretariat, c/o Bouwcentrum, Postbox 299, Rotterdam, The Netherlands.

The Institute of Physics, Conference on Some Aspects of Magnetism, Sept 22-24, Sheffield, England. Conference Secretary, Inst of Physics, 47 Belgrave Sq, London, SW 1, England.

Data collectors in the field will be equipped with a lightweight Motorola "Handie-Talkie" radiophone. This transistorized unit, which has the capability of a 20-tube transmitter–receiver, can be hand carried, placed in a vehicle bracket, or carried in a back pack. The data-collection system will utilize 300 of these portable units.

There are 30 vhf communication channels. These, coupled with the use of microwave, permit vehicle-to-vehicle or person-to-person conversation on each channel. The EOC may, at any time, monitor any of the 30 channels, either one at a time or in groupings.

The system follows a simple automatic pattern. For example, a data collector in the field who may desire to contact another data collector signals the EOC, and through the equipment there, his selected channel is transmitted to the Site Alpha retransmission station and then to the other data collector's radiophone. This is the only procedure that can be followed—even if the radios are standing side by side.

At the present time, mobile test units have assured complete radiophone coverage of 95 per cent of the Hunter Liggett field laboratory. This is a most unique achievement, inasmuch as the 300,000-acre reservation consists of extremely mountainous terrain which has a tendency to hinder radio communications.

Although it was not constructed for long-range reception and transmission, the system has received radio signals from distant points throughout the world under ideal conditions.

Equipment and facilities such as this communications system undoubtedly will be one of the major factors in assuring the efficient accomplishment of the CDEC mission. Soldiers stationed with the CDEC Experimentation Troops receive thorough training in many technical skills through their participation in the experiments.

ELECTRODES being attached to Navy Lt. C. J. Kube in new technique that permits constant watch of his blood pressure, temperature, breath sounds, heart sounds, and brain waves.

Orbiting Flying Laboratory Transmits Physiological Information

THE SUBJECT "Medicine Prepares for the Space Age" was a closed-circuit television presentation at the 11th Annual Scientific Assembly of the American Academy of General Practice at the San Francisco Civic Auditorium.

Captain N. L. Barr, USN, director of the Astronautics Division of the Bureau of Medicine and Surgery, outlined many of the medical problems and peculiarities of man's coming flights into space. Dr. Barr is an authority on space medicine. He has developed systems for gathering physiological information from pilots in the air and from animal and human occupants of Earth-orbiting vehicles. The equipment used in these systems permits transmission of electrocardiograms, electroencephalograms, body temperatures, skin temperatures, respiratory rates, respiratory volumes, and other physiological measures.

Co-operative Effort

In co-operation with the U.S. Navy, the program originated from the Alameda Aviation Physiology Laboratory, across the bay from San Francisco. The telecast was transmitted to the civic auditorium by a new closed-circuit color television system (Eidophor) of CIBA Pharmaceutical Products Inc. ("Huge Color Picture," *Electrical Engineering*, March 1959, p. 284).

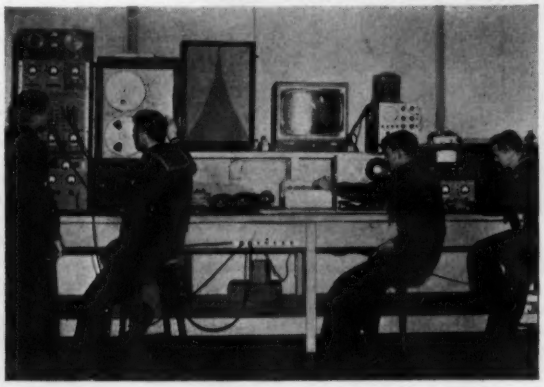
In the demonstration was a complete shore-based receiving unit, developed by the U.S. Navy Medical Department, which permits a constant watch on the physical condition of animal and human occupants of space vehicles. In addition to its application to outer space research, this technique will enable isolated medical practitioners who need the services of medical specialists available only in large cities to transmit all essential information to the specialists by telephone. If a consultant is not available at the time of the call, information can be recorded on magnetic tape and the entire examination episode recreated at a later time. The specialists can hear the heart murmurs, see the pulse pressure, and hear the breath sounds, just as he could if the patient were present in his own office.

Electrode Detectives

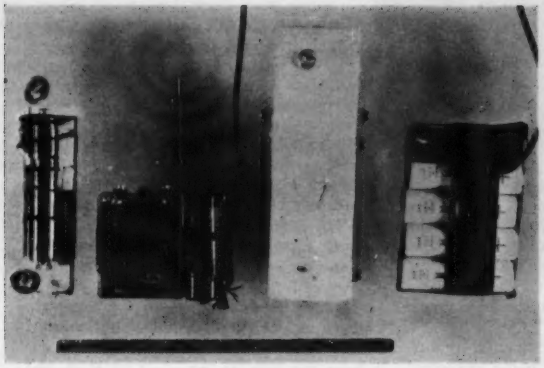
In like manner, electrodes attached to a space man's arms, chest, head, etc. will permit a constant watch with this new technique. The astronaut's blood pressure, temperature, breath sounds, heart sounds, and brain waves, recorded on electrocardiograms, are superimposed on carrier waves and transmitted over world-wide radio and telephone circuits.

Designed for use on ambulatory or exercising patients as a portable electrocardiograph, the equipment was developed at the Naval Medical Research Institute, Bethesda, Md. This subminiature electrocardiogram equipment is now being used in experiments conducted for eventual

DIRECTOR of the Astronautics Division of the Bureau of Medicine and Surgery, Capt. N. L. Barr, USN, is seen at the controls of his recording equipment in the Navy's "flying laboratory" which transmits the physiological information from animal and human occupants of planes, balloons, and Earth-orbiting vehicles to the shore-based receiving unit.



COMPLETE shore-based receiving unit, developed by the U.S. Navy Medical Department, permits constant watch on physical condition of animal or human occupants of space vehicles. Specialists can hear the heart murmurs, see the pulse pressure, and hear the breath sound.



SUBMINIATURE electrocardiogram equipment being used in space-travel experiments. From left to right: electrocardiogram amplifier, transformer, FM oscillator, and dry-cell batteries (each 22½ volts) for FM oscillator.

space travel. It is expected that this equipment will enable medical researchers to collect much important medical data as man responds to space.

Various Demonstrations

One unusual demonstration was the instantaneous projection of the actual electrocardiographic tracings onto the theater-size television screen of a subject as he walked freely about the auditorium stage without direct wire connection. Demonstrations of the physiological characteristics of the squirrel monkey, the first primate to reach outer space, were also presented.

Against a background of newly released film footage of a recent space flight of the Jupiter C rocket, Dr. Barr presented the taped recordings of the electrocardiograms and other medical data of the high-flying monkey, "Old Reliable," as he roared through outer space in the nose cone of the rocket.

Dr. Barr has published over 25 articles and papers on the medical problems of flying. Many of the systems of training and operation he has developed are now standard for naval aviation. Dr. Barr has logged over 12,000 hours of flying time as a pilot and is the only known officer in the military service who is entitled to wear five military aviation wings. He was born in Myrtlewood, Ala., and is 51 years of age.

CIBA is offering this closed-circuit television system, built around the new Eidophor projector, to professional and scientific groups as a public service. The American Academy of General Practice is the second organization to use the new system on the West Coast.

Peaking Gas Turbine Is Complete Generating Station

A new peaking gas turbine, rated 20,500 kw under normal conditions, has been designed for installation as a complete generating station compatible with standard electric utility practices. The new unit was developed from General Electric's 16,500-kw simple-cycle single-shaft gas turbine of which eight are already in service.

With combustion and turbine modifications, the peaking gas turbine operates with a firing temperature of 1,600 F and is designed to burn either natural gas or distillate oils. This specially designed gas turbine would drive a 25,600-kva 13,800-volt air-cooled generator which will produce the electric power.

The turbine itself is some 10½-feet wide and slightly more than 40 feet long. With the connected generator and exciter, the length is extended to 65½ feet. The unit can be installed in a building approximately 28 feet wide and 98 feet long.

The company's engineers envision installation of the peaking station on a subtransmission circuit in order to obtain maximum realization of savings in bulk transmission investment and losses. The peaking gas turbine–generator unit can be supplied with supervisory controls for remote starting and stopping of the gas turbine, as well as telemetering equipment to relay performance and operating data to central power generating stations.

Maintenance of the turbine is expected to be even lower than normal inasmuch as the unit is expected to operate for only limited periods of time. Lubricating oil will amount to only a few gallons per year, and cooling water is expected to be limited to some 30 gallons per minute.

Because gas turbine power output depends on ambient air temperatures, company engineers note that the installed cost will be a function of plant location and the season during which the peak loads are experienced on a given system. For example, if air temperature were 90 F, the net station output would be approximately 20,000 kw. Should the temperature drop to 40 F, output would increase to 23,500 kw.

Isolated-Phase Bus System Completed at Moses Powerdam

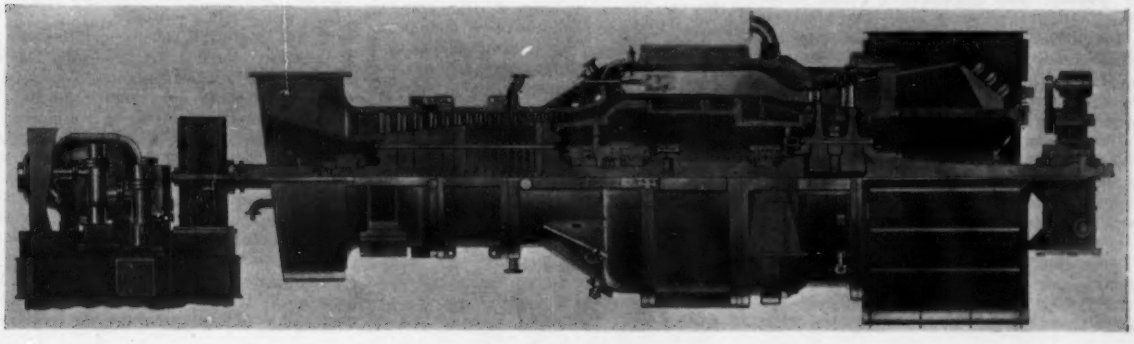
Installation of a large isolated-phase bus system, which connects the generators to the step-up transformers at the 940,000-kva Robert Moses Powerdam, has been completed by the Greensburg Division of the I-T-E Circuit Breaker Company. The Powerdam, now supplying limited power from 12 operating generators, is the American half of the St. Lawrence Power Project at Barnhart Island near Massena, N.Y., the hydroelectric station resulting from the St. Lawrence Seaway Project. When generating at full capacity, the Powerdam will supply enough power to meet the electrical needs of a city of 1 million people.

The 24-inch diameter bus—6,660 feet of king-size high-powered electrical conductor—carries the electrical output of all 16 of the 60,000-kva water-wheel generators at the Powerdam to 12 single-phase 86,000-kva step-up transformers for distribution.

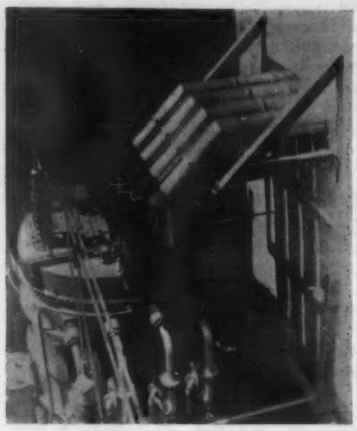
The use of single-phase double-winding transformers in banks of threes, rather than the conventional 3-phase transformers, makes the bus run one of the most unusual ever installed. The generating system is arranged in four groups, each of which supplies 235,000 kva of 3-phase power.

In each of the four groups, two generators are connected in parallel and delta-connected to one winding of each of the single-phase transformers. A second pair of generators is identically connected

▼ Cross-section of General Electric's 20,500-kw peaking combustion gas turbine.



to feed a second delta-connected primary in the same transformer. Because each phase is independent of the other phases, isolated-phase bus gives the flexibility of connection needed for the complicated bus run. Isolated-phase bus differs from segregated-phase bus in that each conductor



FOUR SECTIONS of 3,500-ampere bus leads (top right), connecting to a single-phase double-winding step-up transformer, form part of the 6,660-foot bus structure of the new 940-mva Moses Powerdam. The leads shown are entering a step-up transformer.

in the former is contained in an individual, nonmagnetic tubular housing. In segregated-phase bus, all three conductors are in the one rectangular housing with only a single-thickness wall separating each phase.

The 6,660 feet of bus includes 3,700 feet of 3,000-ampere, 2,300 feet of 3,500-ampere and 660 feet of 6,000-ampere bus. Included in the installation are disconnect switches, instrument transformers, and associated equipment.

Graphite as Textile Has Many Electrical Applications

Manufactured graphite is now being produced in flexible fiber and fabric form. National Carbon Co., Division of Union Carbide Corp., has developed a process to convert organic textile forms directly to graphite with a purity in excess of 99.9%.

In the complex production process, for which patents have been applied, a fiber or fabric such as rayon is graphitized by heating it electrically to a temperature approaching 5,400 F. In this thermochemical conversion, the crystalline structure of the material is changed to that of graphite similar to manufactured graphite used for electric furnace electrodes, nuclear reactor structures, metallurgical molds, or in any other of graphite's myriad industrial uses.

At ordinary pressures, graphite has no melting point, and sublimes only at extremely high temperatures (approximately 6,600 F). It has the unusual property of getting stronger at higher temperatures, and its tensile strength at 4,500 F is about twice that at room temperature. Graphite oxidizes in air at temperatures in excess of 750 F. At the low end of the temperature scale, the known properties of graphite fabrics are unaffected by liquid nitrogen at a temperature of −320 F.

Graphite textiles are resistant to attack by acids, alkalies, and organic compounds, except for those of a highly oxidizing nature, and are unreactive with many molten metals. They have excellent electrical and thermal conductivity, and being in flexible form, are immune to thermal shock.

One field in which experimental quantities of graphite cloth are being evaluated is as a reinforcing agent for various plastics and refractory materials used at high temperatures, such as in the cone of space missiles. Plastic and refractory materials subject to thermal cycling are also an excellent potential use for graphite cloth.

ELECTRICAL CONDUCTIVITY and thermal stability of graphite cloth at high temperatures are demonstrated by means of this evacuated glow tube. A narrow strip of graphite cloth, approximately 10 inches long, is sealed in a vacuum, and attains a white heat when operated on 110 volts. The incandescent strip radiates about 1,300 watts.

Graphite fibers and fabrics can be used to impart electrical and thermal conductivity to nonconducting materials such as plastics, ceramics, and even to other textile materials such as glass cloth.

Its possible electrical uses include resistance heating elements to put heat exactly where it is wanted, and at very high temperatures. Plating, spraying, or vacuum depositing of metals on graphite textiles facilitates making electric connections. Electronic possibilities include thermoelectric elements—possibly "doped" with boron—vacuum tube grids, and infrared emitters. Other potential electrical uses are as static eliminators, and possibly even as a filament material for incandescent lamps.

The company is producing experimental quantities of graphite fibers and fabrics for test and evaluation by industry and military personnel throughout the country.

"Polynya Project" Extends Arctic Shipping Season

A major new blow in man's war against weather—this one aimed at "Old Man Winter"—has been struck at Thule, United States arctic defense post located fewer than 800 miles from the North Pole on Greenland's west coast.

The test campaign, waged by a joint "task force" of United States and Canadian personnel and a few engineers, helped keep Thule's ice-gripped port open to shipping some 40 days past normal closing time last Fall. Further operation of the Thule project—code-named "Polynya" from the Russian meaning an open body of water surrounded by ice—now holds promise of extending the annual shipping season longer than ever before, and starting it weeks earlier than in the past.

This, in the eyes of officers of the U.S. Military Sea Transportation Service (MSTS), means strengthening the free world's defense position, in arctic and perhaps antarctic regions as well.

Industrialists also see application of "Polynya Project" as a means of beating the elements and keeping northern hydroelectric projects and water-borne commerce operating through most winters.

While powerful ice-breakers can lead supply ships into the Thule port, that is only half the battle. Tied up beside the fifth of a mile DeLong Pier at Thule, MSTS ships in the past trapped hundreds of tons of broken ice between them and the pier. That ice "buffer" frequently damaged ships' plates—expensive to repair or replace—and also caused heavy damage to the pier itself as icebreakers moved supply vessels up alongside the pier.

Working in Scandinavian waters for a number of years, Atlas Copco engineers had developed a de-icing system of anchoring compressed air lines beneath the surface. Then, as icing began in the Fall, compressors were placed in operation. Tiny holes drilled at precise intervals in the submerged lines caused new circulation currents—from bottom to the surface. This brought heat up from the warmer bottom depths, preventing the formation of ice and assuring free-water channels.

This was the method that Admiral Eller and his technical staff elected to use in an effort to extend the Thule port season. Although the de-icing installations worked as planned in fresh-water bodies, MSTS officials wanted to apply the system to salt water, if possible.

In slow-moving fresh water, the system proved practically foolproof because fresh water has its greatest density—greatest specific gravity—at 39.2 F. As winter approaches, surface water cools, becomes heavier and slowly sinks toward the bottom. Warmer—and consequently lighter—water from the bottom depths rises toward the surface. This thermal circulation continues until the entire body of fresh water has reached maximum density at the 39.2 degree level.

A change in the water's natural circulation occurs at that point. While cooling continues at the surface as the air temperature falls lower, the surface water no longer sinks to the bottom because its spe-

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cific gravity becomes lighter than water remaining at 39.2 degrees.

As a result, the bottom level water retains heat longer and its freeze-resistance actually is aided once an ice layer forms above it because ice is a poor conductor of heat, effectively trapping warmth below the surface. At the same time, the slow flow of heat from the earth itself helps the earth normally retaining a temperature of approximately 46.5 F.

MSTS personnel first became enthused over this de-icing method after the supervisory naval architect for Adm. Eller's Atlantic Division was sent to examine a number of small craft which had been "iced in" at the Arctic port of Tucktoyactuck in the Northwest Territory. Compressed air bubble systems were used under their sterns to help free them from thick ice.

The possibility of applying the same de-icing system alongside the DeLong Pier at Thule was discussed and Adm. Eller decided to give the system a trial run.

Last October, an Atlas Copco air compressor and other equipment was loaded aboard a naval transport plane at Floyd Bennett Field which made stops at Toronto, Montreal, and Halifax to pick up added supplies. By the morning of October 10, the de-icing team and its equipment had reached Thule to begin installation of the de-icing system. Hydrographic tests in the salt water off the DeLong Pier indicated a trend toward iso-thermal—meaning that both top and bottom-level water temperatures average approximately 29 F. This ruled out complete reliance upon the heat-inversion technique for ice prevention. However, further checks showed high salinity at the bottom. Members of the "Polynya" task force reasoned that compressed air bubbling up from the bottom would carry dense saline solutions to the surface and thereby prevent ice growth almost like warmer water.

Anchoring three air lines at predetermined depths alongside the pier approximately 50 feet apart, the group put the system to work. Within a short time the area alongside the pier was open for berthing and the first of the post-season freighters was brought alongside into the "Polynya" for off-loading.

Shut down at the end of October after the last freight convoy's call at Thule, the de-icing system was reactivated later in the year to determine the effectiveness of the system throughout the winter. While the final decision still is several months away, early indications are extremely favorable.

Miniature Television System Developed

A tiny battery-powered television system, weighing only 9 pounds yet rugged enough to withstand the crushing forces of being rocketed into space, was recently unveiled at the Lockheed Missiles and Space Division in Sunnyvale, Calif.

The entire system, consisting of a camera and three small units which fit easily into a brief case, has a 1,000-mile transmitting range and picture transmission quality

MINIATURIZED missile-borne television system is displayed by research scientist Samuel Schwartz (holding camera) and Daniel Hochman, manager of Lockheed Missiles and Space Division's electrical design department. On table, from left, are camera control unit, power supply and controls for the vidicon, and the transmitter. Hochman holds power supply unit required to operate system.

which compares with commercial television cameras and transmitting stations.

The camera itself is only 7¾ inches long by 2¼ inches in diameter and weighs 42 ounces, including lens. Samuel Schwartz, Lockheed research scientist, has patent applications on portions of the electronic

VIBRATION FORCES it would receive if mounted in a missile are applied to Lockheed's miniature battery-powered television system, but it continues to transmit perfect test pattern to monitor. Noel Biles, electronics engineer, checks performance data. The system also survived other punishing treatment in the company's environmental laboratories.

design of the miniaturized system. Initial development of the system was headed by N. K. Marshall, research scientist.

The television system includes, besides the camera, the fully transistorized control unit, weighing 42 ounces, which supplies all necessary sweep and synchronizing signals to the camera; a 14-ounce unit containing camera controls; and a 50-watt FM transmitter weighing 47 ounces.

The system, powered by a 28-volt dry-cell battery, has passed the most rigorous testing, including 40 g shock, 50 g acceleration, and 10 g vibration. Fifty g has been likened to the force produced by a jet plane smashing into a concrete wall at 1,100 miles an hour.

Daniel Hochman, head of the electrical design department which produced the system, said it has a variety of possible applications in the missile field. "For instance," he said, "it would be possible to see a missile's performance after it was launched and disappeared from sight of ground observers. On a monitor at the ground station you would actually be able to look at such critical things as a stage separation or engine firing."

Commercial potentials mentioned by Hochman could be in the fields of aerial navigation, meteorology, oceanography, railroading, observation of radioactive or similarly contaminated areas, and law enforcement, as well as television news coverage.

Besides its compactness, ruggedness, and adaptability, it has a picture resolution capability of 500 lines—a photographic measure which indicates picture clarity. This is far superior to the picture quality of the average home television receiver.

Northern Lights Are Subject of Research

The sweeping motions of the "northern lights," magnetic storms which blot out radio communications, and data gathered from radar observations of the ionosphere have been tied together in a single theory by Associate Professor Benjamin Nichols of Cornell University's School of Electrical Engineering at Ithaca, N.Y.

Prof. Nichols' explanation, reported in the February 1959 issue of the *Proceedings* of the Institute of Radio Engineers, attributes the celestial occurrences to greater numbers of electrons in the regions where northern lights most frequently appear, and to an increase in the electric field in these same regions.

Prof. Nichols spent a year in Alaska making observations of the northern lights, or aurora borealis, and studying the electrical activity in the ionosphere 60 to 150 miles above the earth. "The movements of the streaks of light-like rays from a searchlight interested me greatly," the professor said. "For the most part, they seem to move in east–west directions, although occasionally there are exceptions. Great clouds of light drift across the sky in much the same pattern."

According to Prof. Nichols, these light movements can be explained by the same theory which accounts for numerous other occurrences in the ionosphere. He noted that many observations have been made of magnetic fields and movements of electrons associated with the aurora borealis. "I have tried to tie these all in together," he said. "I have not, however, explained the aurora as such."

Prof. Nichols' paper is among the first to be published showing results of studies

CORRECTION—In the June 1959 *Electrical Engineering*, pp. 656-57, the diagrams of Figs. 6 and 8 were interchanged. The captions are correct as they appear.

of the ionosphere conducted during the International Geophysical Year (IGY). His auroral studies were carried out at the Geophysical Institute of the University of Alaska while he was on sabbatic leave from Cornell. He has participated in ionospheric research at Cornell since 1949. In 1955, he started a program of refraction studies sponsored by Rome Air Development Center. During the IGY, he supervised the installation and operation of the IGY auroral radar at Cornell's ionospheric research laboratory.

Novel Semiconductor Applications Demonstrated

The "how and where" of semiconductor application has been the marketing theme of the Hoffman Electronics Corporation Semiconductor Division in educating industry in the use of its products.

It was pointed out by the division vice-president that technical advances in the semiconductor field have so out-distanced the awareness of industry that only a small fraction of the usefulness of these devices is being employed.

A production model of a revolutionary electronic "Dollar Bill Changer" changes dollar bills into coins (none can "beat" the machine). This "robot" cashier, an innovation in the vending machine industry, was made possible by the use of Hoffman silicon solar cells, which reliably register the authenticity of paper bills by using light-to-electrical energy conversion principles.

ROBOT CASHIER, developed by the A.B.T. Division, accepts only valid $1 bills and returns change in less than 3 seconds. It is expected to usher in new era in consumer products automation.

A.B.T. Division engineers of Atwood Vacuum Machine Company, Rockford, Ill., working in conjunction with Hoffman, were able to design a simplified and reliable sensing and control system heretofore unattainable. Silicon solar cells were chosen for the job because of their wide spectral response range (4,000 to 11,500 angstroms), high light-conversion efficiency and sensitivity (up to 10%), dependability (10,000 years of useful life, without any appreciable loss in efficiency, according to impartial testing laboratory reports), fifty thousandths of a second response time, and small size-to-power output relationship.

Some power conversion applications include: (1) the Hoffman trans-solar personal radio, (2) Zenith's "Solaris" eyeglass hearing aid, (3) Seth Thomas solar powered electric clock, (4) flashlights, (5) flasher beacons, (6) microwave relay stations, and (7) hydraulic and pump actions.

Among control applications are included: (1) an operatorless freight handling tractor controlled by solar cells which detect variation of reflection of light from white guide line and darker floor, (2) silicon solar cells as "readout" devices in computers, (3) the Atlas missile, with silicon solar cells in its control system, (4) hot metal sensing, and (5) medical diagnostic instrumentation.

Working examples of typical silicon diode circuits and uses created by the company's application engineers have been shown. One model demonstrates the use of silicon diodes, in the forward direction as rectifiers and in the reverse direction (Zener) as regulators. A second display setup allows one to design his own logic "word" patterns on an oscilloscope, using Zener "Magnalog" elements.

In conjunction with the first anniversary of the successful generation of electrical power in Space, through the use of solar cells, Hoffman has displayed an exact working replica of Vanguard I. One of the satellite's radios, powered by the Hoffman solar cells, is still transmitting to Earth after almost 9,000 hours of continuous operation.

Sugar Cube Radio Developed

Radios as small as sugar cubes, using a completely new concept of micromodule circuits and expected to play an increasingly important part in defense electronics, have been successfully developed, the Department of the Army announced recently.

The micromodule program was sponsored by the U.S. Army Signal Corps with the Radio Corporation of America (RCA) as the prime contractor.

The micromodule program, under way since April 1958, marks the beginning of the "cubist" era in electronics. In this new scientific and engineering revolution, the vast range of jobs done by transistors and other electronic parts is being compressed into tiny micromodules—circuit building blocks measuring only a third of an inch on each side. Their small size can save critical space and weight in future satellite systems and rockets.

By using the "disciplined geometry" of micromodules, electronic researchers already have achieved a better than 10 to 1 size reduction over today's most refined equipment using printed wiring, transistors, and other small parts. In some cases, the reduction is 20 to 1 and further compression is considered feasible.

SMALLER than a sugar cube, the electronic radio recently unveiled by the Department of the Army and Radio Corporation of America has a receiver made of micromodules—building blocks which measure a third of an inch on each side and promise a size reduction of 10 to 1 or better in electronic equipment.

The military logistics complex for supporting highly mobile, widely dispersed forces of the modern Army is expected to be simplified by micromodules. Easy replacement of defective parts in electronic equipment would require fewer skilled repairmen. Material tonnage, transport, and storage would be greatly reduced.

Although the developments have been primarily for national defense requirements, micromodules will eventually find their way into homes, commerce, and industry. The wall-type television set, its surface determined by the expanse of the viewing tube and the rest of its components in the rim of the picture frame, is nearer to reality as the result of this new concept. The electronics for record players and dictation machines could fit in a pocket or small purse under the micromodule concept. Button-size batteries already developed would provide power for these and other equipments when electrical sockets are out of reach.

Since the program was launched, tests by Army Signal Corps and RCA engineers show that the tiny cubes promise to be highly dependable, long-lived, use little power, deliver high performance, and greatly simplify repairs. They are extremely rugged because of their simplicity and monolithic shape.

The smallest units of a micromodule are tiny flakes of conducting, semiconducting, or insulating materials, one hundredth of an inch thick and a third of an inch square. Controlled processing of the wafers turn them into microelements with the ability to do the job of specific components such as resistors, transistors, capacitors, diodes, inductors, and crystals. A group of microelements are stacked up, interconnected, and encased to form the micromodule itself. These operate as complete circuits, such as amplifiers, oscillators, and other complex electronic functions.

"Mobot" Works in Deadly Areas

A mobile robot, using television eyes, can "see" and handle dangerous radioactive materials in "hot" areas—and someday may be the first "man" on the moon.

The "Mobot" manipulator has been designed with flexible steel arms and hands plus television-camera eyes by the Hughes Aircraft Co. and revealed at the Nuclear Congress, Cleveland, Ohio (*Electrical Engineering*, June 1959, p. 688). Although it will perform many functions of a man, it will look "more like a fork-lift than a Frankenstein's monster," said Dr. J. W. Clark, head of Hughes' nuclear electronics department in Culver City, Calif., in describing the machine.

Dr. Clark termed the Mobot Mark I "the first of a new family of remote control handling machines which will afford new freedom to companies constructing 'hot labs' for nuclear research."

The Mobot Mark I is now being completed to meet specific research requirements of its purchaser and the company is planning other versions for a wide variety of future uses.

The Mobot Mark I can be applied to almost any situation which is too dangerous for man to undertake by himself, from working in radioactive rooms to handling materials in deep water, it was stated.

Its operation was outlined as follows:

While the Mobot enters a hot area deadly to man, its "pilot" stands in another room, far removed and safe, before a pushbutton panel board and console of monitors. Much as a television director views onstage action from a control room, the Mobot operator sees the hot room through the Mobot's television-camera eyes which send him a picture on a closed circuit. By operating electronic "reins," he can direct the machine to pick up and move radioactive materials.

Television cameras mounted on the walls of the "hot room" give the Mobot operator an over-all picture of the environment, while cameras atop the machine afford forward and rear direction views and additional cameras on Mobot's "shoulders" offer closeups of his fingers at work. Meanwhile, a microphone aboard the mobile robot permits the operator to hear the metal fingers grasp an object.

Mobot can be equipped with auxiliary tools such as wrenches, screwdrivers, hammers, and shears for dismantling radioactive equipment. It can perform a variety of lifting, inverting, and placing operations. It is simple, rugged, and inexpensive, operates electrically by cable or radio link, can lift extremely heavy objects or handle delicate items with tweezer-like care. Its electropneumatic fists and fingers can be adjusted for a light touch or a 200-pound squeeze.

The concept of the remote control handling machine evolved as a result of the full-scale program of radiation experiments being carried out in the company's new underground nuclear laboratories to measure effects of atomic radiation upon electronic components.

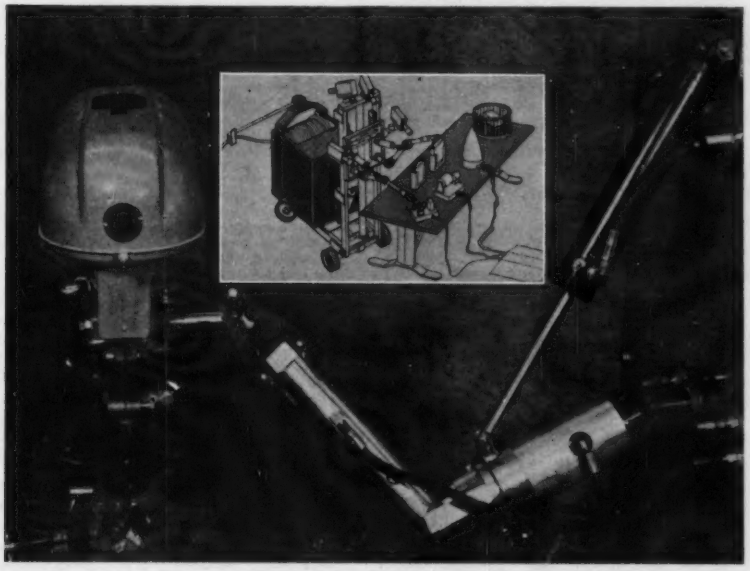
The Mobot under construction may become the granddaddy of a long line of machines which will be designed to perform a wide variety of "brave new world" duties, and will bear little resemblance to their ancestor, Dr. Clark said.

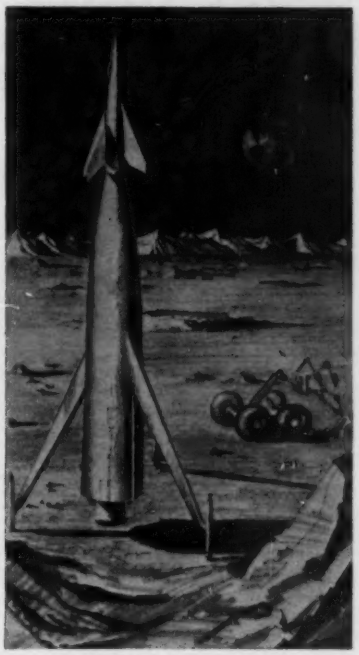
For example, a sketch of a Mobot exhibited by Hughes at the Atomfair depicts a huge double-proboscis insect-like machine on the surface of the moon. It is collecting samples of moonrock and moondust under television direction of a man who accompanied Mobot there by rocket. He remains safely in the spaceship's interior, sending Mobot out on the mooncrust to gather specimens for return to earth labs.

Moreover, a nautical Mobot could have unlimited military and civilian applications for underwater work, even seek sunken treasure. Dr. Clark said that a family of Mobots could do anything at 90 fathoms that it could do on dry land, such as lift a deadweight ton, sink an oil well, or dig a mine shaft. A Mobot fish could be controlled from shore stations, barges, or submarines. A submarine lying at tranquil depths could keep a Mobot at work throughout the worst storms or surface turbulence.

Dr. Clark pointed out that a panel of the National Science Foundation on Oceanography recently urged that more money be spent for research into methods of tapping the vast storehouse of food supplies under the sea.

"In that connection," he said, "a Mobot farmer with a variety of Mobot farm machines could farm the ocean bottom. Crab-like Mobot machines could swim underwater, plant, and harvest kelp, seaweed, and other products in the unexploited sea regions, which produce remarkably high amount of calories per acre, to feed the world's future populations."





FLEXED BICEP (above) shows off Mobot "muscle" as manipulator bends "elbow" to task of operating drill at Atomfair exhibit of Hughes Aircraft Company, makers of the machine for use in "hot" areas. Inset shows sketch of Mobot in "hot" laboratory. Television cameras on walls (not shown) give operator over-all picture of room, while cameras atop machine give forward and rear views as additional cameras on Mobot's "shoulders" offer closeups of fingers handling hot materials. (*Right*) The first "man on the moon" may be a Mobot. Artist's rendering shows future version of machine that would accompany man to moon's surface. It would perform dangerous task of collecting specimens in unknown lunar environment on orders from humans who remain safely in rocket ship.

Missile-Type Magnetic Tape Used in Detection of Disease

The same technique used to analyze the "heartbeat" radio signals from a missile in flight may map the way for the conquest of the Nation's number one killer disease. Scientists at Lockheed Aircraft Corp., Van Nuys, Calif., using sensitive magnetic tape and high-speed electronic computers, have helped develop a weapon for the early detection of arteriosclerosis, the Heart Research Foundation has announced. The disease, known as hardening of the arteries, is the most frequent cause of death in the United States today, producing strokes, heart attacks, and kidney failure.

The missile-type magnetic tape used in the new method records the heartbeat pulsations and blood vessel vibrations of suspected arteriosclerosis victims by means of plastic cuffs on the wrists and ankles. At the company's Missiles and Space Division plant, a specially modified technique converts the sounds on the tape into mathematical terms and then into points and lines on graphs through lightning-rapid computers. These can be analyzed statistically and to an ultrafine degree that could not be accomplished practically by technicians.

Preliminary analysis of this kind shows abnormalities in suspected arteriosclerosis victims accurately and quickly and indicates the severity of the disease if it is present. Because this new means promises to be more accurate in the diagnosis of the early stages of arteriosclerosis than older methods—such as checking the cholesteral fats in the blood—it may prove possible to discover the disease before it has progressed beyond remedial measures and thereby enable physicians to start prompt and effective treatment, the Foundation pointed out.

In addition to its value in diagnosis, the newly developed method may also chart the path for the cure of arteriosclerosis, for which there is no known certain cure at present, although the effects may be halted if treatment is started in time.

The company furnishes the use of its computers and the skills of its scientists and electronic engineers who work in close co-operation with the University of Southern California's School of Medicine. Use of electronic computer equipment and engineering personnel for this purpose is considered a major scientific advance in the compilation of accurate data on heart and circulatory diseases. This new technique is also being applied in the search for an arteriosclerosis cure. Patients undergoing treatment with new drugs and procedures at the Heart Research Foundation in Los Angeles are evaluated periodically to determine effectiveness of treatments. Computer readings of patients' magnetic tapes show the progress being made. The data-analyzing computers accomplish in one hour what would take human technicians many months in studying the records of arteriosclerosis patients. Success of the computer technique in this study may lead to far-reaching advancements in the arrest of other diseases of the heart and blood vessels, the scientists pointed out.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

APPLIED MATHEMATICS FOR ENGINEERS AND SCIENTISTS. By C. G. Lambe. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1958. 518 pages, 6 by 8¾ inches, bound. $8.50. This volume begins with dynamics, which encompasses the motion of a particle, the plane motion of a rigid body, vector analysis, and Lagrange's equations. In addition, there is an account of Fourier series, harmonic analysis, and small oscillations. This is followed by a discussion of statics, specifically statics of a rigid body, statics of strings and chains, and structural statics. The concluding chapters, dealing with hydrodynamics, treat the stability of floating bodies, Bernoulli's equation for liquids and gases, stream functions, and the standard atmosphere. A practical approach is maintained throughout, and numerous examples and exercises illustrate the solution of physical and engineering problems.

THE ATOM AND THE ENERGY REVOLUTION. By Norman Lansdell. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1958. 200 pages, 6¼ by 9½ inches, bound. $6. In this broad introduction to atomic energy and its industrial and social implications, the author discusses world energy resources and demand, new sources of energy, the atom and its energy, methods of releasing atomic energy, sources of natural materials for atomic energy development, the exploitation of atomic energy, and political and commercial organizations for atomic energy development.

BUDGETING: PRINCIPLES AND PRACTICE. By H. C. Heiser. The Ronald Press Company, 15 E. 26th St., New York 10, N. Y., 1959. 415 pages, 6 by 9¼ inches, bound. $10. The book emphasizes budgeting as a prime management tool for continuous profit planning and control. An introductory section provides an over-all review of budgeting for the purposes of planning and co-ordination. A discussion of budgeting for control is presented, including the measurement of deviations from expected performance standards established both for planned and actual operations. The concluding section studies in detail the actual techniques of budgeting and controlling each of 10 major categories of income and expenditure, as well as budget revisions and alternative budgeting practices.

ČERENKOV RADIATION AND ITS APPLICATIONS. By J. V. Jelley. Pergamon Press, Inc., 122 E. 55th St., New York 22, N. Y., 1959. 304 pages, 5½ by 8¾ inches, bound. $10. The classical treatment of the normal Čerenkov effect in isotropic media is presented in detail, together with an account of the underlying physical basis of the phenomenon. For the numerous and varied special cases such as anisotropic media and ferromagnetics, only the results of studies are given, and for detailed mathematical treatments the reader is referred to other sources. Emphasis is placed on the general properties and applications of counters of various types, with inclusion of sufficient technical data to allow the design to be worked out for an instrument for any particular purpose.

CRYOGENIC ENGINEERING. By R. B. Scott. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1959. 368 pages, 6 by 9¼ inches, bound. $5.60. Although the practical aspects of cryogenic processes and equipment are emphasized, an effort is made to include the theoretical fundamentals required for understanding the subject. The major problems encountered in the development and application of low-temperature techniques are described, including the liquefaction and separation of gases, cooling by adiabatic demagnetization, measuring low temperatures, low-temperature insulation, and the storage and transfer of liquefied gases. Two concluding chapters provide handbook-type information on the properties of very cold fluids and solids. The material given treats of the most recent developments and is organized with a view to indicating the feasibility of any new project, as well as the difficulties which may be encountered.

DISPOSAL OF RADIOACTIVE WASTE. By K. Saddington and W. L. Templeton. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1959. 102 pages, 5¾ by 8¾ inches, bound. $3.50. The book provides information relating to the basic data on which the safe limits for radioactive discharge are considered. The information and nature of radioactive waste; the biological effects of radiation; discharge to the natural environment; and the treatment of airborne wastes, liquid effluents, and solid wastes are discussed. The problems likely to arise in the future and the means of coping with them are considered, as is the utilization of individual fission products.

ELEKTROKERAMIK. By Alfred Hecht. Springer-Verlag, Berlin, Germany, 1959. 269 pages, 6½ by 9½ inches, bound. 41.40 DM. Intended for the designer and fabricator of transmission line insulators, this book deals with the materials, methods of manufacture, testing, and use of ceramic insulating equipment. The information varies from specific attention to the achievement of dimensional accuracy in ceramic products to brief general discussion of the importance and status of the ceramic industry.

ELECTROMECHANICAL ENERGY CONVERSION. By D. C. White and H. H. Woodson. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 646 pages, 6 by 9¼ inches, bound. $12.50. The fundamentals of analytical dynamics are used to establish a base for understanding the interactions in an electromechanical system. The first part of the book stresses dynamics, interconnected systems, and feedback control theory. The second part gives detailed and specialized treatments of transducers, commutator machines, induction machines, and synchronous machines. To illustrate the unity that exists in the analysis of machines, a two-phase model of an electric machine is developed and its equation of motion derived and used in all the machine analyses of later chapters.

ELECTRONIC DIGITAL COMPUTERS. By C. V. L. Smith. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 443 pages, 6¼ by 9¼ inches, bound. $12. A comprehensive picture of the basic principles underlying computing machines in use today is presented. The book begins with practical information on such aspects as digital-computer arithmetic; general considerations of systems, circuits, and their components; static and dynamic cells; large-scale memory devices; shifting registers; and adders and accumulators. It then indicates how the basic circuits and devices are assembled and interconnected to form the main units of a computer, and specifically describes the organization of the parallel direct-coupled asynchronous machine developed at the Institute for Advanced Study, Princeton, N. J.

ELECTRONIC FUNDAMENTALS AND APPLICATIONS. By J. D. Ryder. Second edition. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1959. 721 pages, 6¼ by 9¼ inches, bound. $13.35. This edition reflects the belief that the transistor and other semiconductor devices have fully proved themselves. Accordingly, the fundamental phenomena underlying vacuum tubes and semiconductor devices have been consolidated into a joint treatment and points of parallelism have been emphasized. In addition, the introduction of the transistor has been used as an opportunity to correlate electronics and basic network theory, and to emphasize the standard methods once an electronic circuit is reduced to a linear active circuit. Other revisions include new information on single-side-band modulation, diode theory, transistor parameters and circuit analysis, direct-coupled and operational amplifiers, and voltage regulators.

FOURIER TRANSFORMS AND X-RAY DIFFRACTION. By H. Lipson and C. A. Taylor. The Macmillan Company, 60 Fifth Ave., New

York 11, N. Y., 1959. 76 pages, 5¾ by 9 inches, bound. $4.50. This is an introduction to the Fourier transform theory which can be used as a basis for applying the theory to X-ray diffraction. The mathematics are related closely to physical principles, occasionally sacrificing complete mathematical rigidity for greater ease in understanding. Topics discussed include group or molecular transform, diffraction by a crystal, convolution and the peak function, geometry of diffraction, and recombination of the scattered waves.

FUNDAMENTAL ASPECTS OF REACTOR SHIELDING. By Herbert Goldstein. Addison-Wesley Publishing Company, Inc., Reading, Mass., 1959. 416 pages, 6¼ by 9¼ inches, bound. $9.50. Stress is laid on the fundamentals of the subject, specifically the factors affecting the permissible radiation levels, the sources and characteristics of the radiation to be shielded against, and how bulk shielding measurements are made. The book concludes with a detailed analysis of the calculations necessary to determine, theoretically or empirically, the attenuation of neutron and gamma rays in shield materials. Although certain related fields such as radiation biology and nuclear physics are considered, a background knowledge on the part of the reader is assumed.

HANDBOOK OF THE ATOMIC ENERGY INDUSTRY. Edited by S. Jefferson. Pitman Publishing Corporation, 2 W. 45th St., New York 36, N. Y., 1958. Various pagings, 5½ by 8¾ inches, bound. $8.50. A broad summary of the atomic energy industry throughout the world is provided. Included are training and education; atomic energy; industrial, biological, and agricultural uses of radiation and radioactive isotopes; radiation hazards and protection; the handling of radioactive isotopes; and radioactive waste disposal.

INTERFERENCE BETWEEN POWER SYSTEMS AND TELECOMMUNICATION LINES. By H. R. J. Klewe. St. Martin's Press, 175 Fifth Ave., New York 10, N. Y., 1958. 256 pages, 7¼ by 10 inches, bound. $12.50. The problems posed by interference and their solutions are discussed at length in this monograph, which covers coupling between circuits, the characteristics of power systems that affect telecommunication systems adversely, the effects in telecommunication circuits arising from interference, telephone interference by induction at audio frequencies, variations in effects caused by different types of power lines, and reduction of interference. An extensive bibliography is included.

INTRODUCTION TO MONOPULSE. By D. R. Rhodes. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 119 pages, 6¼ by 9¼ inches, bound. $6. A brief description of the concept of direction finding by monopulse is given, and is followed by a unified theory of monopulse in the form of three postulates. The underlying relationships among all of the various forms of monopulse are identified, and these forms are then presented as special cases of the general theory. Succeeding chapters are devoted to these special cases from the standpoint of basic theoretical considerations and representative physical manifestations. Because of military restrictions, the emphasis is primarily on concepts rather than on specific systems.

LOGICAL DESIGN OF ELECTRICAL CIRCUITS. By R. A. Higonnet and R. A. Grea. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1958. 220 pages, 6 by 9 inches, bound. $10. Systematic treatment of Boolean methods for analyzing relay, diode, and vacuum tube circuits, particularly as used in the design of automation systems, computers, telephone dialing systems, and similar applications. Combinational circuits, sequential circuits, and shunt-down circuits are discussed in terms of Boolean algebra, and proven methods are given for simplifying circuits. Problems in the use of relays such as those relating to speed of operation and interference between units are described in detail.

MAGNETIC AMPLIFIER ENGINEERING. By G. M. Attura. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 220 pages, 6¼ by 9¼ inches, bound. $7.50. The book provides basic information on electric and magnetic variables and their interrelation through the equations of Faraday and Oersted. The special characteristics of the magnetic amplifier reactor are discussed and its performance contrasted with the linear inductor. Various types of amplifiers are analyzed such as the saturable reactor, the reactor–rectifier amplifier, and the reversible, single-core amplifier; and typical circuits and applications are described. Special topics treated include hybrid circuits, the bidirectional output amplifier, volt-second analysis of saturable reactors, experimental testing of reactors, and detailed mathematical analysis of the load action of the reactor–rectifier amplifier.

THE MAGNETO-IONIC THEORY AND ITS APPLICATIONS TO THE IONOSPHERE. By J. A. Ratcliffe. Cambridge University Press, 32 E. 57th St., New York 22, N. Y., 1959. 206 pages, 5½ by 8¾ inches, bound. $7.50. A detailed account is given of the theory concerned with the propagation of electromagnetic waves through a partially ionized gas in the presence of a magnetic field. Two approaches are adopted in developing this theory: a macroscopic one in which the properties of the medium are averaged out, and a microscopic one based on the motion of the individual electrons. Graphical representation is then discussed and simple rules demonstrated for computing curves of refractive index and absorption index as functions of electron density. Applications of the theory to the earth's ionosphere is studied, and a wide range of phenomena capable of explanation in terms of the magneto-ionic theory of a homogeneous medium are indicated.

MATERIALS AND PROCESSES OF ELECTRON DEVICES. By Max Knoll. Springer-Verlag, Berlin, Germany, 1959. 484 pages, 6¼ by 10 inches, bound. 61.50 DM. This is a practical manual for the physicist or engineer concerned with designing and building electron devices such as high-vacuum tubes, gas- or vapor-filled rectifiers, thyratrons, X-ray or luminescent tubes, flow or incandescent lamps, Geiger or ionization counters, vacuum photocells, photoconductive cells, diodes, and transistors. Extensive information is provided on the preparation and working of materials used in these devices; the finishing methods for vacuum tubes, particularly degassing, pumping, and getter procedures; and the production of solid-state devices. A valuable feature is the inclusion of approximately 2,300 references.

MATHEMATICS APPLIED TO ELECTRICAL ENGINEERING. By A. G. Warren. Second edition. Chapman and Hall, Ltd., London, England, 1958. 464 pages, 6 by 8¾ inches, bound. 70s. A comprehensive survey of the mathematics used in electrical engineering is presented. In this edition, the two chapters on operational calculus and Fourier analysis have been completely rewritten and a new chapter on functions of a complex variable has been added. Other new or rewritten sections discuss analogs, eddy current methods of nondestructive testing, and modulation, as well as material on the use of analog computers to solve differential equations.

MODERN TRANSISTOR CIRCUITS. By J. M. Carroll. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 268 pages, 8¾ by 11¼ inches, bound. $8.50. Almost 200 circuits are given with complete design information and electronic component values. Circuits are arranged both by generic types such as amplifiers, oscillators, power supplies, and pulse circuits, as well as by specialized application such as broadcast equipment and home entertainment; audio and r-f communications circuits; missile, aircraft, and satellite telemetering equipment; test instruments; and industrial, scientific, and medical devices. Particular emphasis has been given to new circuits combining transistors and electron tubes, and transistors and magnetic amplifiers.

NOISE IN ELECTRON DEVICES. Edited by L. D. Smullin and H. A. Haus. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 413 pages, 6 by 9¼ inches, bound. $12. The papers contained in this collection are the result of a course on "Noise in Electron Devices" which was held at the Massachusetts Institute of Technology. They cover the general problem of noise due to thermionic emission, the general circuit aspect of noise in microwave tubes, some of the detailed engineering solutions to the problems encountered in the design of low-noise traveling-wave tubes and space-charge control tubes, semiconductor noise, noise behavior of semiconductor diodes and transistors, and the principles of low-noise transistor circuit design. In general, stress is placed on basic physical phenomena and mathematical theory rather than on detailed design techniques.

OPTICAL PROPERTIES OF SEMI-CONDUCTORS. By T. S. Moss. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1959. 279 pages, 5¾ by 8¾ inches, bound. $9. The opening chapters of the book provide a theoretical treatment of the optical properties of conducting media, absorption and emission processes, interrelation of the optical constants, magneto-optic effects, and all internal photoeffects. Reviews of the properties of the more important semiconductors are then given, including group IV and group VI elements; intermetallic compounds of groups III and V; and chalcogenides of lead, zinc, and cadmium.

OSZILLATOREN MIT SCHWINGKRISTALLEN. By Werner Herzog. Springer-Verlag, Berlin, Germany, 1958. 317 pages, 6¼ by 9½ inches, bound. 45 DM. This text deals with the design and properties of crystal oscillators both with electron tubes and with transistors. Theory is discussed as a basis for the simple calculation of any type of oscillator. Special aspects covered include the oscillator with high-frequency constant, an explanation of the Nyquist theorem on the basis of practical examples, quality change with relation to changes in the resonance frequency, and, for the practical engineer, an effective method for determining desired oscillator characteristics.

PATENTS FOR ENGINEERS. By L. H. A. Carr and J. C. Wood. Chapman and Hall, Ltd., London, England, 1959. 107 pages, 5½ by 8¾ inches, bound. 18s. British patent law is dealt with briefly and in simple terms with emphasis on engineering and commercial aspects. Among those topics considered are an outline of the British patent system; legal aspects, including rights, actions, and kindred rights such as trade marks; patent specifications; historic patents; and miscellaneous provisions dealing with the validity of a patent, infringement, and employees invention. Technical legal phraseology has been avoided where possible.

PHYSICAL LAWS AND EFFECTS. By C. F. Hix, Jr. and R. P. Alley. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1958. 291 pages, 6 by 9¼ inches, bound. $7.95. This compilation provides a brief description of approximately 100 familiar and unfamiliar laws and effects, an indication of their expected magnitude, and reference to further sources of information. The book is intended as a source of useful concepts in research developments, and among the varied topics included are the Barkhausen effect, luminescence, Bremstrahlung radiation, Curie–Weiss law, thermoelectric effects, memory metals, and stress-strain effects.

PROGRESS IN NUCLEAR ENERGY, (Series X, Law and Administration, Vols. 1 and 2). Edited by H. S. Marks. Pergamon Press, 122 E. 55th St., New York 22, N. Y. 1959. 994 pages, 6½ by 9¼ inches, bound. $26.50. The legal

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ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

and administrative aspects of nuclear energy are presented in two volumes bound as one. The first deals with the broad features of the law and its administration in the United States and the United Kingdom, and with Euratom and other important international agencies and arrangements. The second is a compilation of the laws and decrees that 25 representative countries have adopted. Brief introductory commentaries preface and help to explain the laws and decrees published. Also included in this volume are the treaties, international agreements, and related documents establishing the international agencies and arrangements described in the first volume.

QUALITY CONTROL AND INDUSTRIAL STATISTICS. By A. J. Duncan. Revised edition. Richard D. Irwin, Inc., Homewood, Ill., 1959. 946 pages, 6¼ by 9¼ inches, bound. $10.80. The basic principles and procedures of statistical quality control are presented. Beginning with a section on the fundamentals which covers probability, frequency distributions, and sampling, the author continues with sampling inspection and control charts. The concluding part discusses statistical theory pertinent to industrial research and includes the estimation of lot and process characteristics, the theory of comparisons, analysis of components of variance, regression, analysis of covariance, and design of experiments. In this edition, practically all of the material has been revised and expanded.

RADIOACTIVITY MEASURING INSTRUMENTS. By M. C. Nokes. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1958. 75 pages, 5½ by 8¾ inches, bound. $4.75. Instructions are given for making several types of simple radioactivity measuring instruments. They can be made at low cost in the average laboratory. Included are chapters on the Geiger–Muller counter, phenomena in Geiger–Muller tubes, trigger devices, power supplies, counting rate meters, and scalers.

THE RADIO AMATEUR'S HANDBOOK. Published by the American Radio Relay League, West Hartford 7, Conn., 1959. 36th edition. 584 pages, 6½ by 9½ inches, paper. $3.50. A new edition of a well-known reference work which contains practical information on various phases of radio communications, including receivers and transmitters of various power levels. Special methods of communication such as single sideband and radioteletype are also treated. The theory and practice of mobile radio equipment is thoroughly covered, and includes the fundamentals of transistor power supplies. A special feature is the section on vacuum-tube characteristics which provides one of the most complete listings of characteristics and tube-base diagrams available.

RADIO ENGINEERING HANDBOOK. Edited by Keith Henney. Fifth edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. Various pagings, 6 by 9¼ inches, bound. $25. This is a revision of a well-known handbook which provides working principles, standards, and procedures that are applicable to both routine and special assignments in radio engineering. In addition to covering broadcasting, aircraft radio, television, facsimile, and navigation aids, new sections have been added on wire-guided communication. All chapters have been brought up to date and new developments are presented in such areas as diodes, high-frequency tubes, transistors, nonlinear circuits, audio-frequency circuits, and power supplies.

SELEKTIVSCHUTZ. By H. Neugebauer. Second edition. Springer-Verlag, Berlin, Germany, 1958. 273 pages, 6¼ by 9¼ inches, bound. 28.50 DM. This text on the protection of electrical equipment against short circuits deals first with the measurement of electrical quantities and the determination of the types and places of failure. The second part takes up the special switchgear by which protection is established for generators, motors, transformers, electric lines, and bus bars.

SEMICONDUCTORS. (American Chemical Society Monograph Series Number 140). Edited by N. B. Hannay. Reinhold Publishing Company, 430 Park Ave., New York 22, N. Y. 1959. 767 pages, 6 by 9¼ inches, bound. $15. A thorough survey of the physical chemistry and fundamental physics of semiconductors is presented, with emphasis throughout on basic principles and phenomena. Following a general discussion of the subject, the authors deal with the physical chemistry of semiconductor systems, the relationship between the chemistry and the electrical and optical properties of a number of semiconductors, and the properties associated with semiconductor surfaces. Heavy emphasis has been placed on germanium and silicon, primarily because they are much better understood than other semiconductors.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

SOVIET PHYSICS — SOLID STATE. A translation of the USSR Academy of Sciences journal, *Fizika Tverdogo Tela*, this monthly publication offers results of theoretical and experimental investigations in the physics of semiconductors, dielectrics, and on applied physics associated with these problems. The periodical will also publish papers on electronic processes taking place in the interior and on the surface of solids. The journal is being made available by the American Institute of Physics, 335 E. 45th St., New York 17, N. Y. Subscription rate is $55 for the U. S. and Canada ($59 elsewhere).

WHAT'S MUFFLING THE VOICE OF THE ENGINEER? This report is an edited transcript of what was said at the Engineering Public Relations Forum held by the Public Relations Committee of Engineers Joint Council (EJC) in November 1958. The problem considered was how to raise the prestige of the engineer in the public mind. Some of the aspects discussed were communication of engineering news to the public, technical jargon, the public relations potential of the new United Engineering Center, and the responsibilities inherent in a public relations program. The 24-page report is available at 50¢ from EJC, 29 W. 39th St., New York 18, N. Y.

RCA RECEIVING TUBE MANUAL. Technical Series RC-19. This manual has been prepared to assist those who work or experiment with electron tubes and circuits. The material in this edition has been augmented and revised to keep abreast of the technological advances in electronic fields. Major sections of the manual include: electrons, electrodes, and electron tubes; electron tube characteristics; electron tube applications; electron tube installation; interpretation of tube data; and technical data on tube types. The manual may be ordered from the Electron Tube Division, Radio Corporation of America, Harrison, N. J., at 75¢.

AEC PUBLICATIONS. The following releases from the U. S. Atomic Energy Commission are available: *Increased Availability of Tritium for Civilian Applications*, B-62; *AEC Proposes Regulatory Amendments Setting Lower Limits on Radiation Exposures*, B-63; and *Highlights of AEC Licensing Activities, December 1958–January 1959*. TI-77. Copies may be obtained from the U. S. AEC, Washington 25, D. C.

NEMA STANDARDS. The following publications of Nema standards have been made available: *Industrial Heating Units and Devices*, HU 1-1959, 30¢; *Precision Snap-acting Switches*, IC 3-1959, 30¢; *Color Coding of Wires and Cables*, WC-1959, 30¢; *and Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy*, WC 3-1959, $4. All four may be ordered from National Electrical Manufacturers Association, 155 E. 44 St., New York 17, N. Y.

1959 ENGINEERING SOCIETIES DIRECTORY. Representing the first revision of this publication since June 1956, the Directory provides basic information concerning international, national, regional, state, and local engineering groups, and includes address, membership, secretary, and organizational publications. It is divided into 6 major sections: international organizations; joint bodies in the United States; national engineering societies; state, regional, and local bodies; registration boards; and Canadian engineering societies. The Directory may be obtained for $3.50 from Engineers Joint Council, 29 W. 39 St., New York 18, N.Y.

1959 PRICE LIST AND INDEX OF AMERICAN STANDARDS. The publication lists the more than 1,800 American Standards approved to date by the American Standards Association (ASA). Also included in the publication are the international standards recommendations published by the International Organization for Standardization and the International Electrotechnical Commission. The volume is available free from ASA, Dept. PR 66, 70 E. 45th St., New York 17, N.Y.

OTS PUBLICATIONS. Two U. S. Air Force reports dealing with testing devices developed for electronics equipment have been released to industry. A prediction technique which enables a designer to estimate the quantitative reliability of electronic equipment in the field is described in "Reliability Prediction and Test Results on USAF Ground Electronic Equipment," *PB 151041*, J. J. Naresky, 25 pages, 75¢. The second report, "Study of Electron Tube Shorts and Discontinuities," *PB 151489*, W. A. Barrows, 188 pages, $3, concerns the development of a mechanical short generator and an electromechanical short and open generator for short-testing electron tubes. Both reports may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

1958 BOOK OF ASTM STANDARDS. Within the 13,600 pages of this 10-part volume are contained 2,450 standard specifications, methods of test, definitions of terms, and recommended practices. Each part is complete with a detailed subject index and a list of standards in numeric sequence. Supplements will be issued to each part late in 1959 and 1960 in order to keep the book up to date. As a service, a complete index is furnished without charge with each set. The complete set is priced at $116, and may be ordered from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

PROCEEDINGS OF 1958 NATIONAL ELECTRONICS CONFERENCE. The book, Volume 14, contains transcripts of the papers and discussions presented at the international meeting held in Chicago, Ill., in October 1958. Papers describe latest developments in a wide range of areas including transistors, servomechanisms, audio, network theory, microwaves, instrumentation, computers, industrial electronics, and engineering management. Containing 1,080 pages, the cloth-bound volume may be purchased at $7.50 each from National Electronics Conference, Inc., Rm. 2104, 228 N. La Salle St., Chicago 1, Ill.

NATIONAL BUREAU OF STANDARDS PUBLICATION. Notice has been given that the National Bureau of Standards (NBS) now publishes its *Journal of Research* in four separate sections, corresponding to subject matter fields, which may be subscribed for individually. The change was made to permit more effective dissemination of the Bureau's findings to science and industry. The four sections of the *Journal* are: Physics and Chemistry, to be issued 6 times a year at $4 annually ($4.75 foreign); Mathematics and Mathematical Physics, to be issued quarterly at $2.25 annually ($2.75 foreign); Engineering and Instrumentation, to be issued quarterly at $2.25 annually ($2.75 foreign); and Radio Propagation, to be issued 6 times a year at $4 annually ($4.75 foreign). Subscriptions may be ordered from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

IRE TRANSISTOR WORKSHOP LECTURE NOTES. Lecture notes on the use and applications of transistors from the April-May 1959 lecture series sponsored by the Boston Section of the IRE have been made available in one volume. The volume may be ordered at $5 postpaid through the office of the Boston Section, IRE, 73 Tremont St., Boston, Mass.

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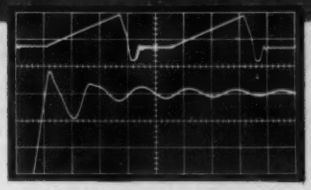

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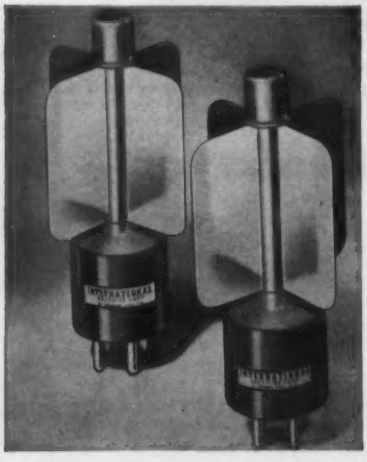

less than $\frac{1}{16}$ their equivalent in tube circuitry. Other advantages are extremely long life under very high or low operating temperatures, no warm-up time requirement, and ruggedness. **International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.**

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erratic behavior of certain materials during processing. With this improved portable meter, the location and intensity of the electrostatic charge is indicated on a linear scale graduated between —10 and +10 units to show polarity and relative degree of charge. Three sensitivity ranges of the meter are provided by adjusting the apertures built into the probe. **The Simco Co., 920 Walnut St., Lansdale, Pa.**

Brighter Electroluminescent Lamps . . .

Raising the voltage or stepping up the frequency are two ways of increasing electroluminescent brilliance. But higher voltage is destructive to the lamp and most available frequency converters are bulky and inefficient. However, this newly developed static high-frequency converter, which has no moving parts, vacuum tubes, or contacts to wear out, will produce a frequency range from 2 to 10 kc from regular powerline frequency or a d-c battery current source. Illumination is increased tenfold with this change in frequency. **Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.**

Miniaturized VHF Amplifier . . .

Evaporative cooling, a new means for protecting airborne electronic equipment from heat generated internally by its components, is used in the design and operation of this new 5-kw output vhf amplifier. During operation, the heat is conducted directly into water, causing boiling, and the boiling water then serves as a coolant as the result of vaporization and the release of steam. Heat transfer from components which cannot be immersed directly in water is accomplished with *FC-75* Fluorochemical. By using this technique, the weight of the entire unit, including power supply, has been brought down to less than 200 pounds, and its size to less than 3 cubic feet. **The Martin Co., Baltimore, Md.**

5-Kva Static Inverter . . .

Said to be the highest rated fully transistorized inverter yet developed, this standby power unit will find useful application in microwave communications links and other military and civilian power applications where continuity of operation is important. In the event of a power line failure, the model *4058* inverter can be automatically switched into the circuit to convert battery power at better than 90% efficiency while the auxiliary engine-driven generator is being brought up to speed. **Transval Electronics Corp., Culver City, Calif.**

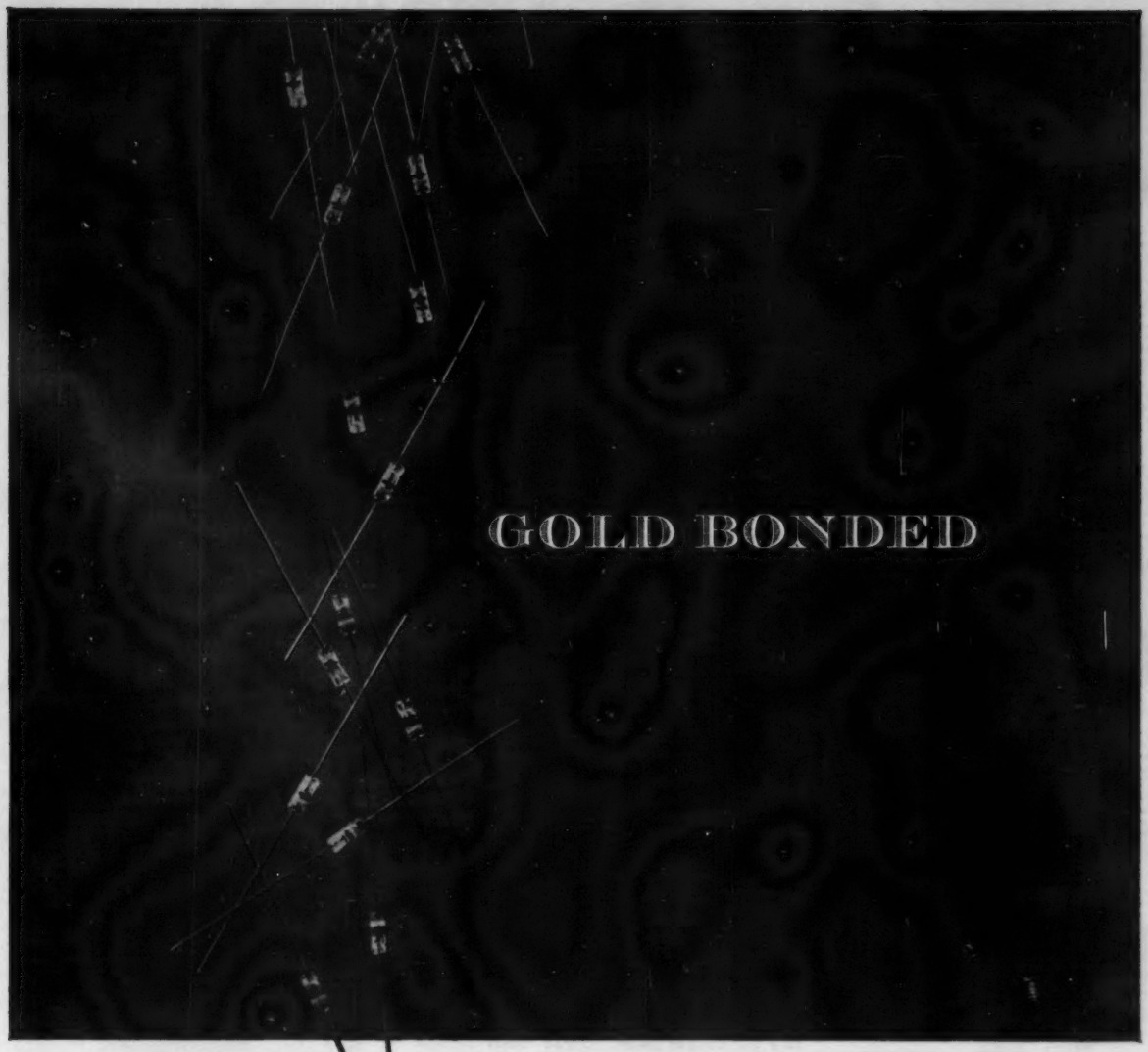
Pencil-Drawn Graph Tracer . . .

Data-Trak translates into proportional electrical signals process control or programming instructions fed in the form of a double pencil-drawn curve on ordinary graph paper. Any soft or medium graphite pencil may be used and parts of the curve may be erased and changed at will. A probe under the drum holding the graph is continuously servo-driven to a null position midway between the two pencil lines defining the plotted function. A precision potentiometer is geared to the stylus servo so that its slider always bears a position relationship to the plotted function. This device will find useful application in the regulation of temperature, pressure, speed, and position in automation of industrial processes. **Research, Inc., 115 N. Buchanan, Hopkins, Minn.**

Automatic Engine-Starting Control . . .

This new automatic engine-starting control, intended for fully automatic starting and stopping of engine-driven generating sets, is a natural outgrowth of developments in the field of automatic transfer switches. Industrial control type components are used throughout and coded terminals facilitate installation with any engine. Other features are positive no-crank at full engine speed, controls designed to respond at 50% of normal battery voltage, and provision for repeated cranking cycles by the same panel. **Automatic Switch Co., Florham Park, N. J.**

(Continued on page 20A)



HUGHES GERMANIUM DIODES

first of all for reliability.

Typical performance levels: @ 25°C. unless otherwise stated

	Forward Current @ +1V (mA min.)	Inverse Current @ Specified Voltage (μA max.)	Maximum Inverse Voltage (Volts)
1N270	200	100 @ −50V	100
1N276	40	100 @ −50V 100 @ −10V*	60
1N277	100	250 @ −50V* 75 @ −10V*	125

*Measured @ 75°C.

For additional information write: Hughes Products, Marketing Dept.—Semiconductors, International Airport Station, Los Angeles 45, California.

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance... vibration resistance... thermal stability... electrical stability.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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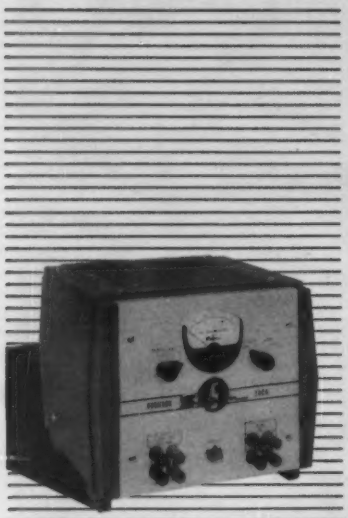
SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

NEW IDEAS IN PACKAGED POWER

for lab, production test, test maintenance, or as a component or subsystem in your own products



New addition to Sorensen B-supply family features outstanding versatility. A voltage range of 0-300 vdc, at up to 150 ma, regulation within ±0.15% or 0.3 volt, complete flexibility as to polarity or grounding, heater supplies of either 6.3 or 12.6 volts ac, and provisions for external sensing are big features of the new Sorensen Model 300B (left). It's one of the most adaptable B supplies ever. Outputs of two Model 300B's may be connected in parallel for higher current or series for higher voltage without introducing instability or impairing regulation. Model 300B may also be connected to supply constant current within a specified range. Sorensen has B Nobatrons to supply almost every need of electronic research lab or precision equipment builder. They come in output voltages up to 1000-vdc; models have adjustable front-panel controls and hold their regulation over an astonishingly wide voltage range. Bench or rack-mounting models. Write for specs.

New unregulated supplies offer economy, wide adjustment range. Unregulated, but highly adjustable, the new Sorensen RC-Nobatron Rangers, like the Model RC36-30 (left), are exceptionally simple and rugged d-c supplies consisting basically of a variable autotransformer and rectifier-filter circuit. They come in models to supply 0-36 or 0-150 vdc and each model has an auxiliary a-c output of 0-130 vac. Each voltage range comes in two power capacities (approximate maxima): (1) 500 watts dc and (2) 1 kw dc. A transformer completely isolates d-c output from a-c input and output; entire circuit is completely isolated from chassis ground. D-c output voltmeter and ammeter supplied. Available for bench or 19" rack. All models: 115 vac, 60 cps. E-45

See your nearest Sorensen Representative or write us for complete details on these new Sorensen d-c power supplies. And may we remind you that our engineers are always ready to consider your special power supply needs, whether this involves modification of an existing unit or the design of a complete power system to meet complex requirements.

Sorensen

SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. IN WESTERN CANADA, ARVA. IN EASTERN CANADA, Bayly Engineering, Ltd. IN MEXICO, Electro Labs, S. A., Mexico City.

New & Improved Products

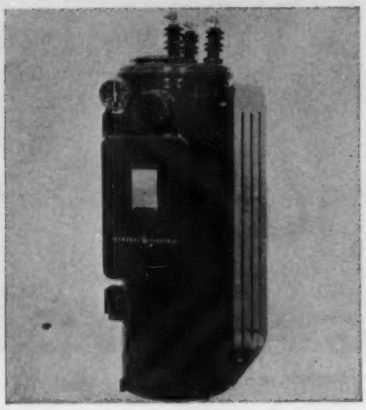
(Continued from page 18A)

New Fluorescent Lamp . . .

A fluorescent lamp that requires neither starter nor external ballast, and which can be mounted in a single conventional screw base, has been developed. A bimetallic starting switch does away with the need for an auxiliary starter. An incandescent filament within the lamp eliminates the need for an external ballast and serves to emit additional lumen output and supplements the normal blue-green color with the reddish color characteristics of incandescent tungsten. **Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa.**

Step Regulator Improvements . . .

Four design improvements provide better performance, easier maintenance, and greater safety in these single-phase step voltage regulators. Flat-panel cooling radiators that are said to be more efficient coolers and easier to clean and repaint replace the hollow-fin radiators formerly used. Three other features make it easier



Courtesy General Electric

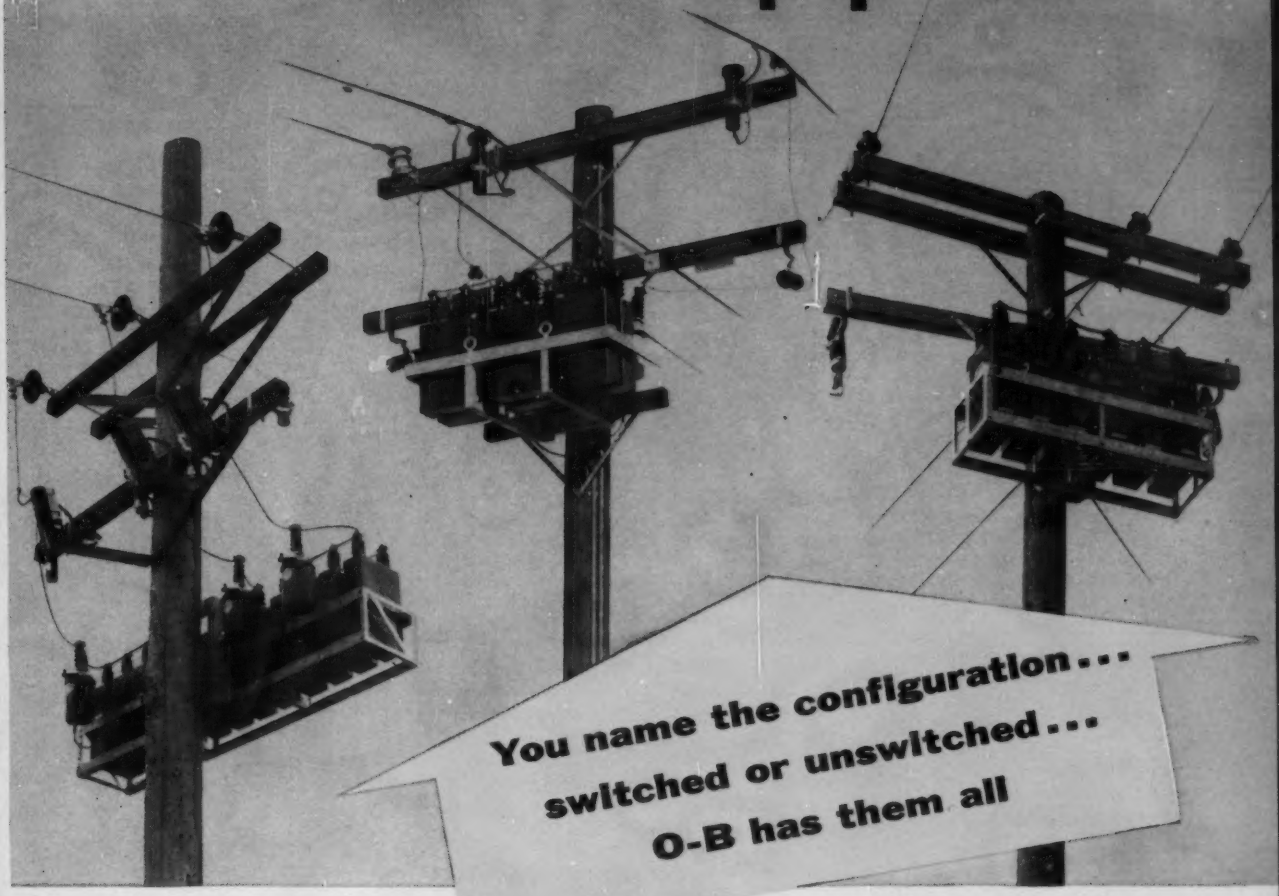
to reassemble the regulator after untanking: namely, (1) the position indicator now has a flexible drive shaft, with a slot-and-key coupling that assures duplication of the factory setting; (2) nine separate internal control circuit connections have been mounted on one plug-in connector; and (3) guides assure easy positive positioning of the core-and-coil assembly after untanking. **General Electric, Schenectady 5, N. Y.**

Hot-Stick Tester . . .

Designed for testing insulated tools, this device can be carried and operated by one man, requires no special skill to use, and will not damage a hot stick that has absorbed excessive moisture. It measures true leakage independent of stray capacitance currents. **A. B. Chance Co., Centralia, Mo.**

(Continued on page 24A)

Buy VAREX® In Your Choice of Pole-Mounted Equipments



We won't challenge you to specify a pole-mounted equipment arrangement that O-B can't supply. You might outguess us but there are literally thousands of combinations to choose from. Basically, you can have in-line, rectangular and cluster arrangements -- switched or unswitched, with your choice of switch manufacturer, and any number of units from 1 to 24.

There are a few points to make concerning the rack designs. Although the equipments are shipped on wooden skids, they are designed so that the lower frame members constitute a skid in themselves. The "boxed-in" style of the rack provides a permanent shield for the entire equipment.

Now for the convenience features. Our engineers know, for example, that linemen treat lag screws like nails, driving them into the pole when an equipment is mounted. So mounting brackets are arranged to give the lineman plenty of room for a full swing at the screw heads.

We also have rubber caps for capacitor and switch terminals, big lifting eyes, 5-kv insulated cable and any other quality feature you'd like to name. But despite these features, the big advantage is the Varex unit that goes into the equipment -- foil-cooled, stainless steel terminal studs, spring pressure contact on elements, low height, and with O-B's own wet process porcelain bushings in a compression assembly that assures leak-free operation. Regardless of the equipment you choose, you get the full range of Varex advantages.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

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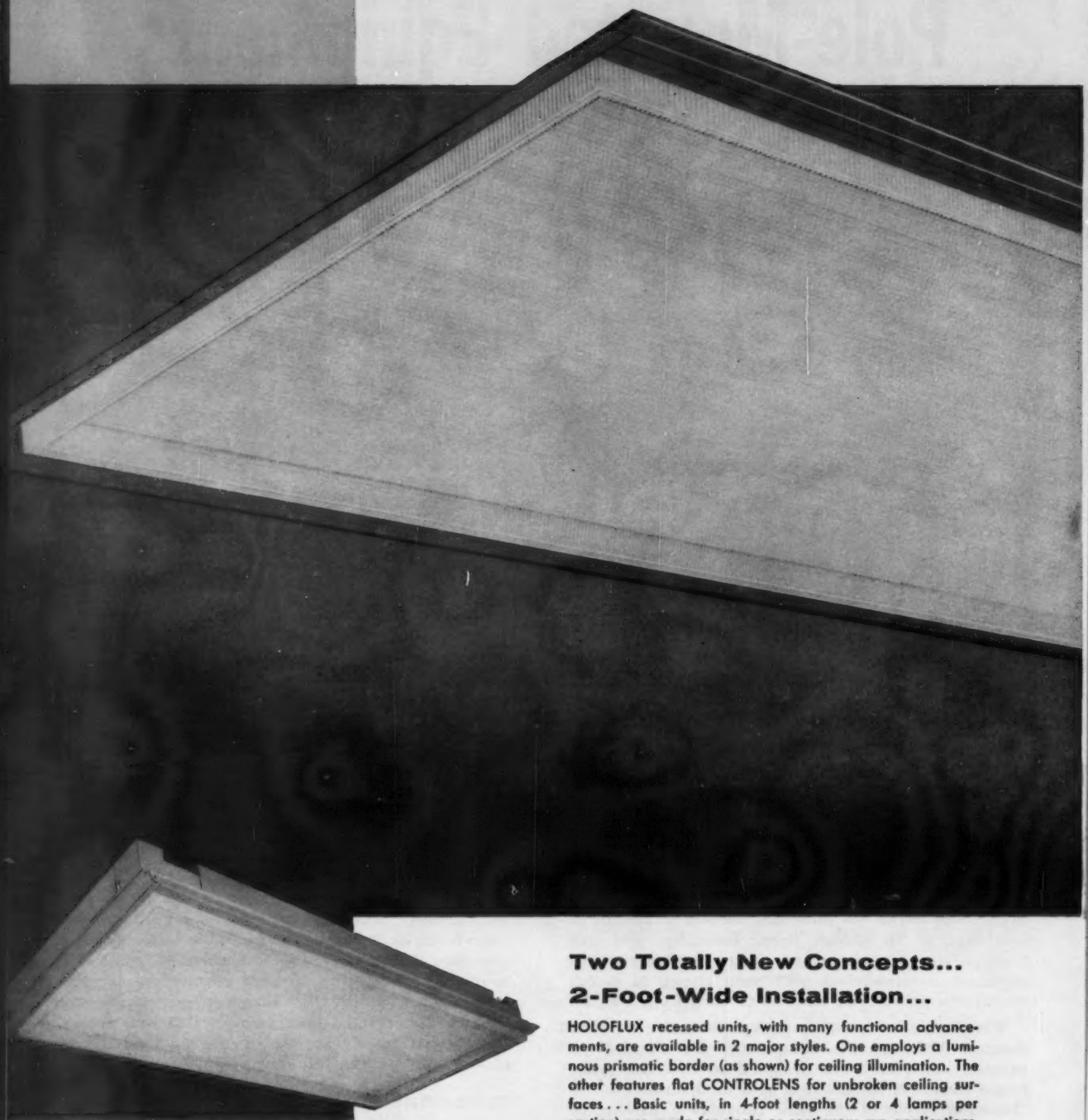
From the Heritage of HOLOPHANE Craftsmanship...



Two Totally New Concepts...

2-Foot-Wide Installation...

HOLOFLUX recessed units, with many functional advancements, are available in 2 major styles. One employs a luminous prismatic border (as shown) for ceiling illumination. The other features flat CONTROLENS for unbroken ceiling surfaces . . . Basic units, in 4-foot lengths (2 or 4 lamps per section) are made for single or continuous run applications.

Exceptional Versatility...

Wide Range of Applications

HOLOFLUX satisfies the increasing demand for highly efficient, prismatically controlled, recessed lighting. Its distinctively simple, streamlined design integrates with a wide variety of contemporary interiors: stores, offices, showrooms, banks, public buildings, waiting rooms, sales offices, airport public areas, institutions. Recommended for today's low-ceiling installations.

HOLOPHANE COMPANY, INC.
342 Madison Ave., New York 17, N. Y.
We'd like to learn more about your HOLOFLUX 6400 SERIES. Please send installation and engineering data, without obligation.

INDIVIDUAL _____

ORGANIZATION _____

STREET _____

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A Most Important ADVANCE in Recessed LIGHTING...

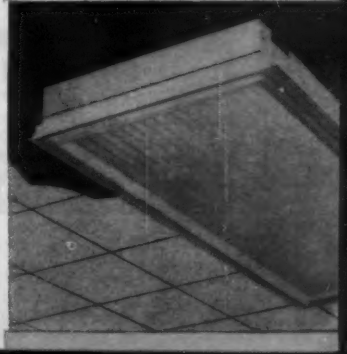
Holoflux

Series 6400

Here's the Future of Lighting—
Ready NOW...for Today's Interiors...

All the specialized skills and experience accumulated by HOLOPHANE through 61 years of lighting leadership have contributed to the development of this latest achievement—the new HOLOFLUX* family of luminaires... Unique illuminating advantages, never before available, are made possible by the PRISMALUME* (acrylic plastic) CONTROLENS*. These lenses are crystal clear, light in weight, shatter-resistant, and free from discoloration. They are molded to provide prismatic patterns that assure highest efficiency, lowest brightness, upward (ceiling) light... HOLOFLUX mechanical features: very shallow fixture; easy installation; great rigidity for continuous runs (no visible metal); positive action door; economical maintenance.

For all types of ceilings: Holoflux units are engineered for easy installation in all modern forms of ceilings, including the inverted "T", "Z" and "H" spline; also in the ordinary and acoustical plastic ceilings.



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Lighting Authorities Since 1898
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*Trade Marks

* GTC PROVED RELIABILITY

IN-PLANT COMMUNICATION SYSTEM

FIRST MAJOR INSTALLATION PLACED IN SERVICE IN U. G. I.'s LUZERNE ELECTRIC DIVISION'S HUNLOCK CREEK GENERATING STATION

February 1958

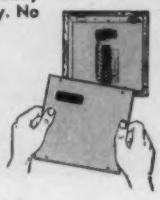
Since that time, the GTC system delivered constant, uninterrupted service. New plant unit will include extension.

This installation, as well as thousands of GTC units that have been installed in power stations and industrial plants throughout the United States since, have definitely established the superiority and reliability of GTC in industrial voice communications.

Features contributing to GTC's acceptance and reliability are:

1. Provides swift and sure voice communication even in adverse environmental conditions, such as extremes of temperature and noise.

2. All amplifiers are "plug-in" contributing greatly to ease of installation and maintainability. No central equipment is required.



3. Long-life transistors and rugged, industrial type components are used throughout. No vacuum tubes or "entertainment" type components are employed.

4. Inconvenience and expense of vacuum tube replacement is eliminated.

5. Design allows expansion of system from "very small" to "very large" by simple addition of units where required.

6. Ultra simple wiring plan (no shielded cables) and unitized equipment with integral terminal facilities make for easy low cost installation.

*Gai-Tronics Transistorized Communications is an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.

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GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet and name of nearest representative.

New & Improved Products

(Continued from page 20A)

Plastic Pinch Bracket and Vibration Damper . . .

Two newly developed products, both made of high-impact vinyl, are applicable to open line wire installations. The one-piece plastic pinch bracket provides 4-inch cradled, controlled spacing of open line wire between transposition points and eliminates an insulator, a steel plate, a steel pin, and two bolts usually found in conventional pinch bracket assemblies. The vibration arrester is a plastic spiral coil wrapped around the wire so that the reduced helix is at the end near the support where potential fatigue damage is greatest. **Preformed Line Products Co., 5349 St. Clair Ave., Cleveland 3, Ohio.**

Three-Phase Monitor . . .

Here is a monitor that instantly warns of electrical distribution system trouble and gives both visible and audible signals for unbalanced transformer loads, grounds, single phasing, and loose connections. The minimum and maximum voltage warning points can be set for each phase. If the voltage drops below these points, a phase

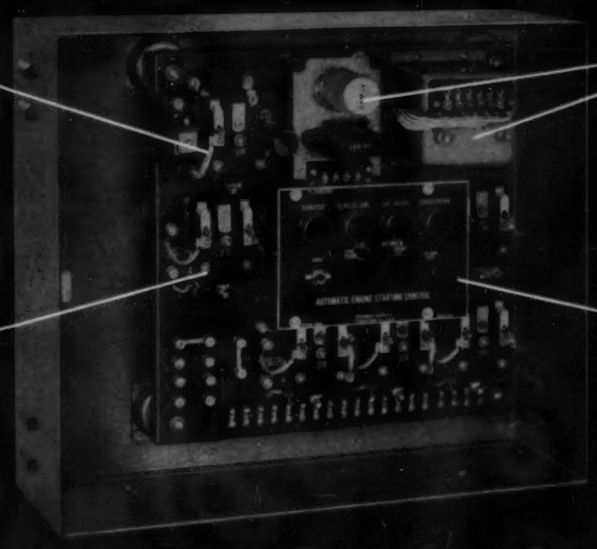
pilot light goes on and the alarm bell rings. At this time, the nature of the difficulty can be determined quickly by reading the three voltmeters and comparing with the illustrated meter chart on the face of the instrument. **Principle Research & Development Corp., 200 Citizens Bldg., Aberdeen, S. Dak.**

Atomic Power Plant Simulator . . .

An instrument unit that impersonates a full-scale atomic power plant was developed primarily as a training device for colleges and universities, but can also be used independently to solve nuclear design and operational problems. The operating characteristics of virtually every type of atomic heat-exchange power plant can be duplicated when linked to a reactor simulator which behaves the same as a reactor using fissionable fuels. **Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.**

(Continued on page 33A)

ONE OF A SERIES: ASCO Complete Emergency Control Systems put Standby Power in action FAST



Unique crank disconnect relay prevents recranking at full engine speed.

Heavy Duty Industrial Components provide dependable, rugged service.

Positive Response Relays do not require critical adjustments or frequent maintenance.

Inverter-Timer Combination assures constant cranking periods despite wide variations in battery voltage and ambient temperature.

Link Connections provide manual or automatic shutdown of engine.

Indicating lamps, fuses, and manually operated switches are integral part of control panel... eliminate wear on cables when door is opened... make unit suitable for switchboard applications.

ASCO Engine Starting Controls offer...

extra protection for your standby power equipment!

ASCO Engine Starting Controls provide fully automatic starting and stopping of diesel or gas engine driven generating sets. They offer the extra protection of a unique disconnect relay which positively prevents recranking while engine is running at full speed... helps eliminate danger of damage to starting gears. And control operation is fast... only 1/30th of a second!

Dependable control by ASCO...

ASCO

Automatic Switch Co.

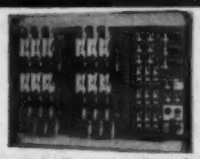
50-K Hanover Road, Florham Park, N. J. FRontier 7-4600

For additional information write for Catalog 57-S6.

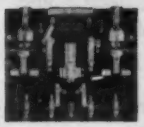
Here are other important benefits of new ASCO Controls:

ASCO FEATURE	YOUR BENEFIT
Controls designed to respond at 50% of normal battery voltage.	Assures starting even after high cranking current reduces battery voltage.
Operates over broad ambient temperature range.	Can be installed in unheated areas of plant.
Repeated or continuous cranking cycles provided by same panel.	Makes unit adaptable to all engines.
Industrial control type components throughout.	Provides rugged, sure service, not possible with light duty components.
Motor driven timing device.	Assures accurate control of timing cycles—unaffected by temperatures or other variables.
Can operate from single pole contact on automatic transfer panel or control station.	Reduces installation time and costs.
Coded terminals.	Eliminates guesswork in connecting engine and starting panel; simplifies installation.

OTHER ASCO CONTROL SYSTEM COMPONENTS:



Automatic Transfer Switches *for all classes of load to 750 volts AC-DC. Transfer connected load to standby power when failure or substantial reduction occurs. Return load automatically when full power is restored—in sizes from 10 to 1200 amps. Write for Catalog 57-S1.*



Load Demand Controls *automatically start engine when load is applied; stop it when load is removed. Write for Catalog 57-S6.*

Solenoid Valves *for air starting applications, and for controlling the flow of cooling water, fuel oil and other liquids and gases. Write for Catalog 25.*

Solenoids *for fuel control devices, operating shutters for engine cooling, and other electric plant applications. Write for Catalog 57-S5.*

Battery Chargers *for heavy duty industrial use keep engine generator cranking batteries fully charged. Charger can be combined with automatic transfer panel for compact, single package arrangements. Write for Catalog 57-S6.*

GENERAL CONTRACTORS: Campbell Construction Co., Detroit, Mich.
ARCHITECT & ENGINEERS: Campbell Engineering Co., Detroit, Mich.
ELECTRICAL CONTRACTOR: Southeastern Electric Co., Detroit, Mich.

Electrical Protection goes MODERN *with* BUSS Fuses

in the Hoover Tool & Die Co., Centerline, Mich.

This new industrial plant on the outskirts of Detroit illustrates that the modern trend in electrical protection is to fuses. The main switch gear is a 1600 ampere pressure switch protected by BUSS Hi-Cap fuses. The distribution panels, both power and light, are equipped with FUSETRON dual-element fuses.

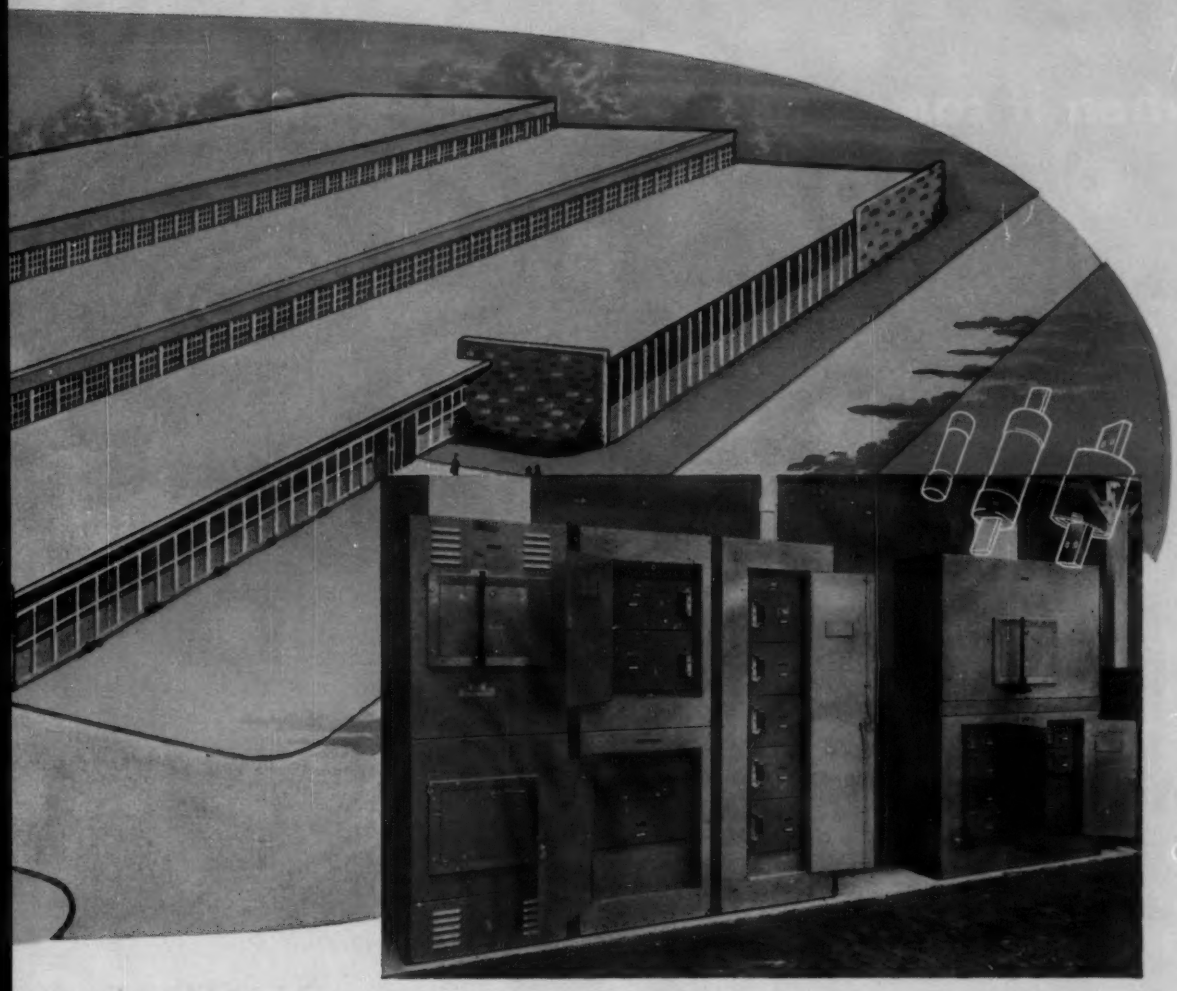
This plant will have many operating advantages because fuses are installed. *For instance:*

Future expansion without sacrificing safe protection.

Provisions were made to install a second 1600 ampere pressure switch when needed. This additional capacity and any increase in available fault current can safely be handled by BUSS Hi-Cap and FUSETRON dual-element fuses.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION



Main Power Panels —
BUSS Hi-Cap and FUSETRON Fuses

Through the year's savings result from the greater dependability of fuses.

Unlike mechanically operated devices, a fuse has no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

After years of service, a fuse will give the same safe, dependable protection if called upon to open as it would have given on the day it was installed.

The dependability of BUSS Hi-Cap and FUSETRON fuses helps to reduce costs — by preventing damage and loss due to electrical faults — by being maintenance free — by requiring no periodic inspections — and by eliminating shutdowns caused by needless outages.

Is it any wonder then that "ELECTRICAL PROTECTION IS GOING MODERN WITH FUSES"? No other type of protective device can match the combined high-interrupting capacity, dependability and maintenance-free features of fuses.

For more information

On BUSS Hi-Cap fuses . . . . *Write for bulletin HCS*

On FUSETRON dual-element fuses . . . . *Write for bulletin FIS*

BUSSMANN MFG. DIVISION, McGraw-Edison Co. ST. LOUIS 7, MO.

when it comes to CUTOUTS

* **PRESSURE-RELIEF CAP CUTOUT** photographed in action discharging the cap, fuse link button head, and ionized gases upward into the primary.

* *Both photographs are open shutter exposures, taken of cutouts tested on a 15 kv circuit with 8000 amperes available.*

* **HUBBARD EHD FAULTMASTER CUTOUT** with exclusive Single-Vent Small-Bore action discharging all gases down and away in a single confined cone.

Manufactured in Canada by N. Slater Co., Hamilton, Ontario

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- Molectronic Devices
- Microwave Systems and Components
- Radar Systems
- Network Synthesis
- Analogue and Digital Computer Design
- Electronics Instructors
- Communications Circuitry
- Field Engineering
- Technical Writing
- Electronic Packaging
- Operations Research

Write for "New Dimensions" . . . the informative brochure that takes you behind the scenes at Westinghouse-Baltimore today.

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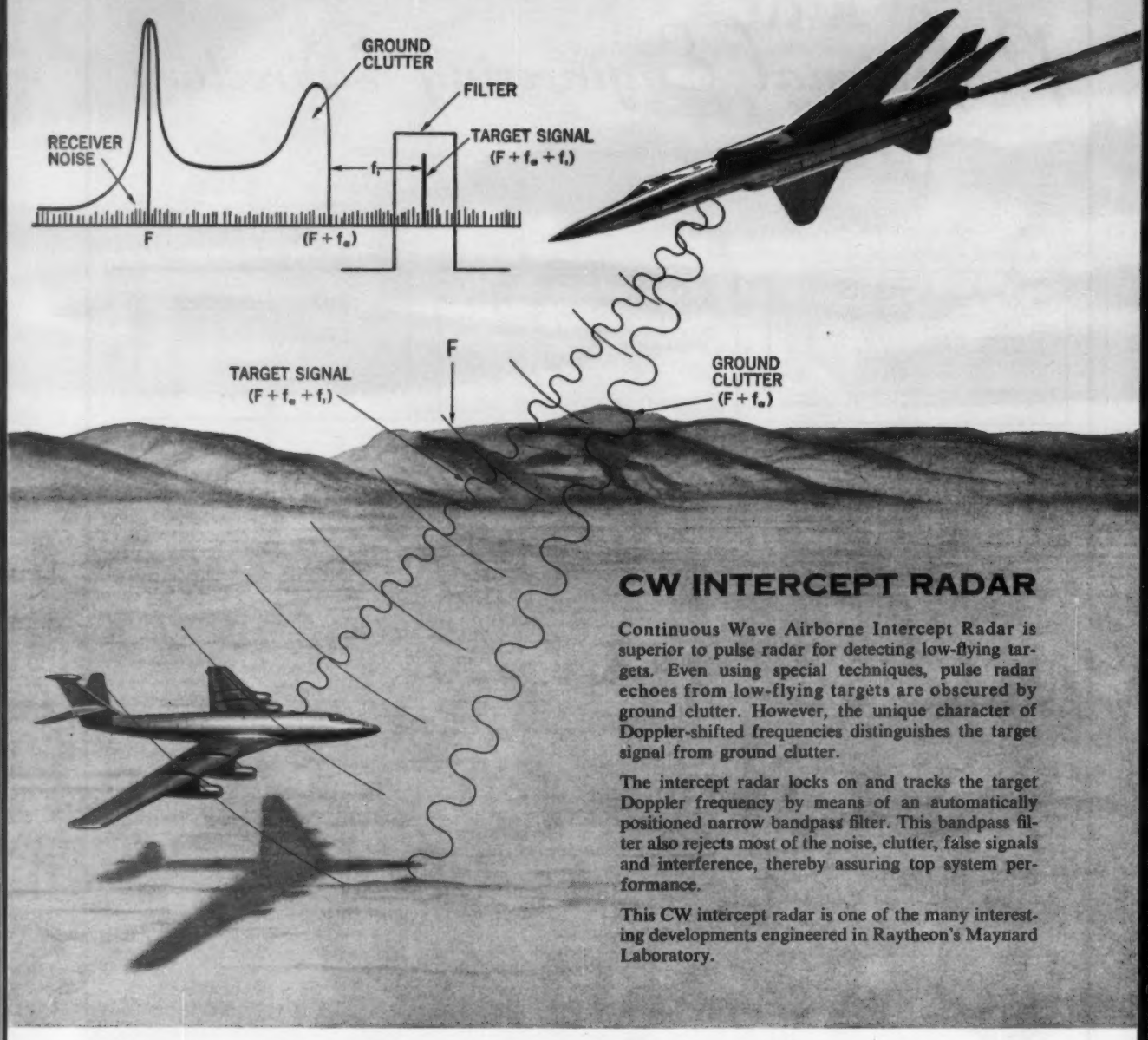

CW INTERCEPT RADAR

Continuous Wave Airborne Intercept Radar is superior to pulse radar for detecting low-flying targets. Even using special techniques, pulse radar echoes from low-flying targets are obscured by ground clutter. However, the unique character of Doppler-shifted frequencies distinguishes the target signal from ground clutter.

The intercept radar locks on and tracks the target Doppler frequency by means of an automatically positioned narrow bandpass filter. This bandpass filter also rejects most of the noise, clutter, false signals and interference, thereby assuring top system performance.

This CW intercept radar is one of the many interesting developments engineered in Raytheon's Maynard Laboratory.

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Raytheon has excellent openings for qualified engineers and physical scientists with BS or advanced degrees. Positions are available in systems, development, design or manufacturing engineering of complex electronic equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Rd., Framingham, Mass.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *North Dighton, Waltham, Mass.*

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GOVERNMENT EQUIPMENT DIVISION

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New Products

(Continued from page 24A)

Adjustable Limit Switch . . .

A new limit switch, designed for use on conveyors, machine tools, and various types of automation equipment, allows the switch's arm length to be varied to fit any specific application and permits the component to be mounted safely out of

the path of moving pieces. The arm is made up of three pieces; the roller portion fastens to a length of ¼-inch key stock, which in turn is inserted into the section fastened to the switch, while the key stock may be cut to any desired length. **Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.**

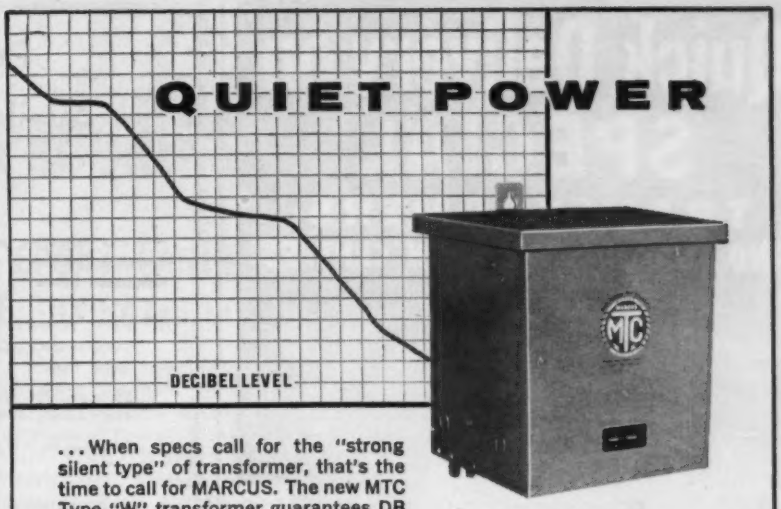
Noise Meter . . .

A palm-sized noise survey meter to monitor and measure noise hazards weighs only 12 ounces and is not much larger than an electric shaver. The M-S-A meter is designed for rapid, multilocation measurement of sound levels to establish noise-contour maps in large industrial plants and is an especially convenient tool for acoustical design specialists. **Mine Safety Appliances Co., 230 N. Braddock Ave., Pittsburgh 8, Pa.**

Glass-Ceramic Wafers . . .

Tiny, precision-made wafers of Fotoceram make possible the production of circuit assemblies said to be 10 times smaller than any made before. The wafers serve as resistors, transistors, capacitors, and diode bases in the new micromodule circuit assemblies. Precision made by a photo-etching process, they have an operating temperature of over 500 C, have great strength, and possess excellent electrical characteristics. **Corning Glass Works, Corning, N. Y.**

(Continued on page 49A)



...When specs call for the "strong silent type" of transformer, that's the time to call for MARCUS. The new MTC Type "W" transformer guarantees DB LEVELS THAT ARE BELOW NEMA STANDARDS. So for those extra quiet installations, Specify MARCUS---- Proven quieter by independent laboratory test.

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A COMPLETE LINE OF DRY-TYPE AND LIQUID-FILLED TRANSFORMERS FROM 1 THROUGH 5000 KVA.

ELECTRICAL ENGINEERING PROBLEMS IN THE RUBBER AND PLASTICS INDUSTRIES (August 1958)

Publication T-106 consists of 11 papers and discussions presented at the Tenth AIEE Conference on Electrical Engineering Problems in the Rubber and Plastics Industries, held at Akron, Ohio, April 14-15, 1958. Also included are introductory remarks, keynote address, and index of papers presented at previous meetings.

Sponsored by the Subcommittee on Rubber and Plastics Industries of the AIEE General Applications Committee, the 150-page publication is available for $4.00 from

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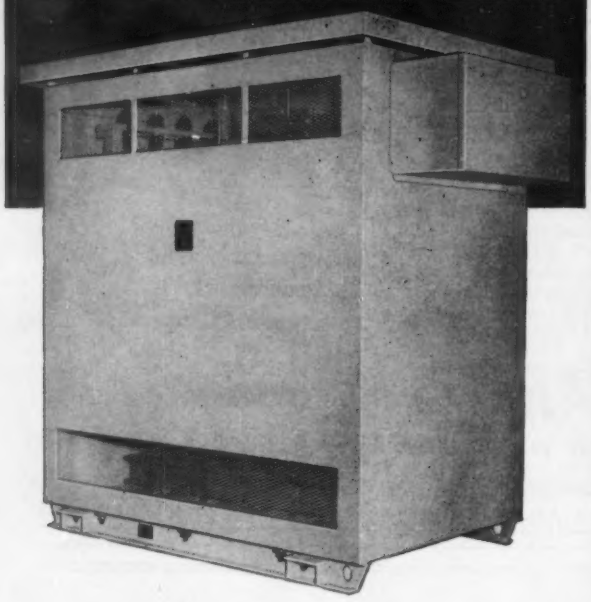

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1. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers in Business and Industrial Systems), Nov. 7-9, 1955, Boston, Mass.

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   100 pages, 15 papers and discussions. Price: $3.00.

2. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers with Deadlines to Meet), Dec. 9-13, 1957, Washington, D.C.

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   259 pages, 48 papers and discussions. Price: $3.00.

3. **PROCEEDINGS OF THE WESTERN JOINT COMPUTER CONFERENCE,** Feb. 26-28, 1957, Los Angeles, Calif.

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4. **PROCEEDINGS 1957 ELECTRONICS COMPONENTS SYMPOSIUM,** May 1-3, 1957, Chicago, Ill.

   Sponsors: AIEE, The Institute of Radio Engineers, Radio-Electronics-Television Manufacturers Association, West Coast Electronic Manufacturers Association; also Agencies of the U. S. Department of Defense, and the National Bureau of Standards

   282 pages, 43 papers. Price: $5.00.

5. **1958 NATIONAL TELEMETERING CONFERENCE,** June 2-4, 1958, Baltimore, Md.

   Sponsors: Institute of Aeronautical Sciences, AIEE, Instrument Society of America, American Rocket Society

   317 pages, 63 papers and abstracts. Price: $4.00.

6. **NONLINEAR MAGNETICS & MAGNETIC AMPLIFIERS PROCEEDINGS,** Aug. 6-8, 1958, Los Angeles, Calif.

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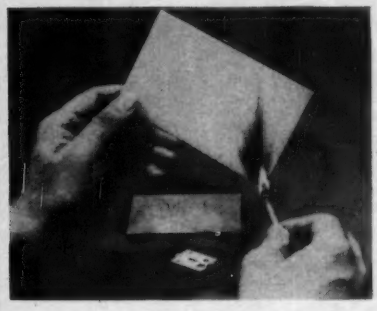
Much is being said lately about the fabulous epoxies. No better use, however, has been made of these remarkable resins than the development by CDF of new improved laminates for electrical-insulating purposes.



New CDF epoxy Dilecto laminate exhibits flame-retardancy in simple match test.

CDF epoxy Dilecto® laminates, made with either treated glass-cloth or cellulose-paper base, combine the highest strength-to-weight ratio and the highest impact strength with low water-absorption, low loss properties, and improved machinability. The new epoxy Di-Clad® laminates for printed-circuit use also display exceptional foil-bonding strength, high hot-solder-resistance, and higher maximum operating temperatures than previously obtainable in standard laminates.

And now permanent flame-retardancy and excellent arc-resistance are added to many grades of epoxy laminates from CDF, both GB and XXXP. These laminates, known as the EFR series, meet NEMA G-11 and MIL-P-18177B, Type GEB. This combination of properties should further widen the range of applications for this superior insulating material. CDF Technical Bulletin 11200 describes epoxy Dilecto and Di-Clad laminates in detail.

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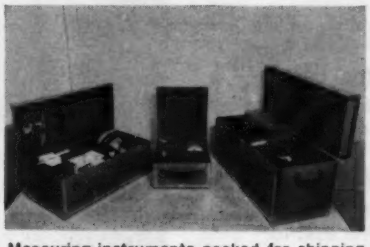
Replacing heavy, costly wooden cases for the transport of delicate aircraft and electronic instruments, CDF now offers fiberglass-reinforced polyester cases containing integral rubber-coated kapok cushioning, built for repeated usage with a wide range of instrument sizes and shapes. The complete line of new CDF instrument-shipping cases ranges in size from 12" x 14" x 7" to 25½" x 11" x 12½".



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CDF. Excellent electrical properties, resistance of all common chemicals, and a low coefficient of friction characterize these new tapes, designed primarily for high-temperature and high-frequency wire and cable insulation. However, they may be used also as stock from which gaskets, seals, and miscellaneous small parts can be cut.

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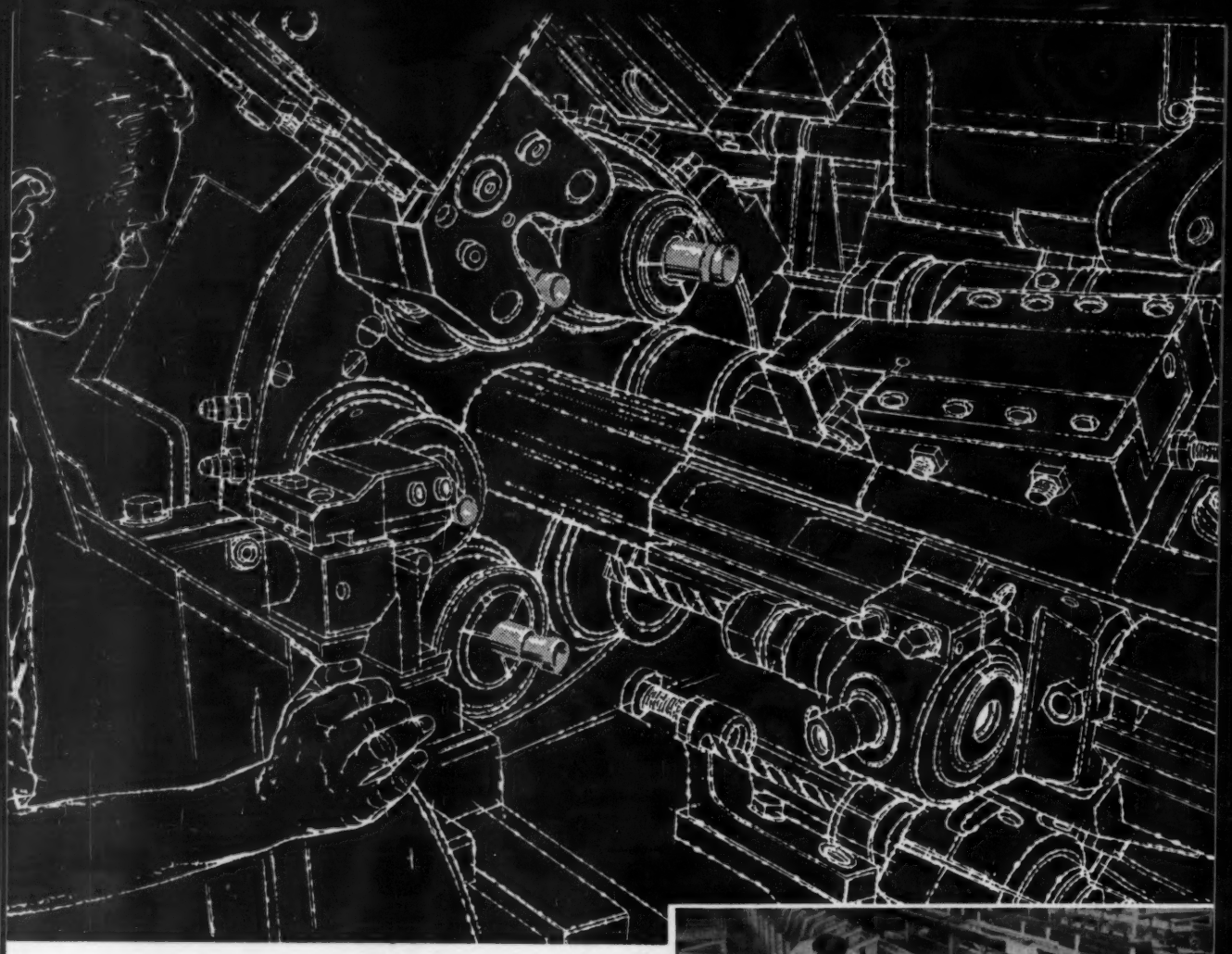

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ELECTRON TUBE DIVISION

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Industrial Notes . . .

Inertia Switch, Inc.
New York, N. Y. . .

A move to new, enlarged quarters at 311 W. 43d St., New York, N. Y. has been announced by Inertia Switch, Inc. The new offices provide greater facilities for engineering, laboratory, administrative, and sales departments. Inertia Switch is the designer and manufacturer of a new kind of acceleration-sensitive switch weighing one ounce and with only one moving part. An illustrated brochure on the switches is available from the company at the new address.

The Garrett Corp.
Los Angeles, Calif. . .

A contract to supply the vital environmental control system for NASA's Project Mercury manned satellite has been awarded to the Garrett Corp., AiResearch Manufacturing Division, 9851 Sepulveda Blvd., Los Angeles 45, Calif. Prime considerations in selecting AiResearch over seven competing firms were its system and its more than 20 years' experience in developing and manufacturing environmental control systems for military and commercial airplanes, according to the McDonnell Aircraft Co., which awarded the contract to the Los Angeles firm.

Leece-Neville Co.
Cleveland, Ohio . . .

A major acquisition, designed to diversify its product line to include commercial products in addition to those now being supplied to the general transportation industries, has been anounced by P. H. Neville, president of the Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio. The company has purchased the A. C. Motor Division of the O. A. Sutton Co., Wichita, Kan. The acquisition represents the company's first move into the a-c motor field, with motors soon to be produced for use on air conditioners, fans, dehumidifiers, evaporative coolers, furnaces, and space heaters, forced air electric heaters, vibrator mechanism drives, and similar products.

Microwave Electronics Corp.
Palo Alto, Calif. . .

Formation of Microwave Electronics Corporation, for research, development, and manufacture of microwave electronic devices, has been announced. The company, which is privately financed, is incorporated in Delaware and will do business in California. The executive offices, laboratory, and manufacturing plant have been located at 4061 Transport St., Palo Alto, Calif. The facilities provide 10,000 square feet of working space. The initial emphasis will be devoted to work on traveling-wave amplifiers and backward-wave oscillators. The firm plans to develop a proprietary line of tubes covering a broad frequency range.

Rockwell Manufacturing Co.
Pittsburgh, Pa. . .

One of the largest electric steel foundries under one roof has been completed in Atchison, Kan., by LFM Manufacturing Co., a subsidiary of Rockwell Manufacturing Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. The foundry now can

ship 3,000 tons per month. The LFM foundry melting facilities include one of the largest types of electric furnace used by steel foundries. Other innovations include a mechanized slinger mold department, a pneumatic core sand transport system, and a pneumatic core sand reclamation system.

National Cash Register Co.
Hawthorne, Calif. . .

A $90,000 contract has been awarded to the National Cash Register Co., Electronics Division, Hawthorne, Calif., by Wright Air Development Center Aeronautical Research Laboratory for photochromic memory research. The contract, which is of one year's duration, calls solely for theoretical and experimental investigation of photochromic memory techniques and devices leading to possible future application in an ultra-high-density memory.

A. M. Byers Co.
Pittsburgh, Pa. . .

To withstand the effects of highly corrosive salt water atmospheres, special conduit has been installed on the new $6 million highway-railroad causeway between Pelican Island and Galveston, Texas. More than 37 tons of *4-D* wrought iron conduit, made by A. M. Byers Co., 1810 Clark Bldg., Pittsburgh 22, Pa., were utilized to carry power and telephone lines across Galveston Ship Channel. The recently completed causeway, which includes a bascule bridge, is part of a multimillion dollar Pelican Island industrial and commercial development program.

(Continued on page 41A)

For squirrel-cage, wound-rotor, and synchronous motors to 1500 hp

1. **Arc chutes** are easily removed for tip inspection, and all components can be quickly replaced if necessary.
2. **Pre-installed protective devices** save valuable installation time. General Electric circuit breakers are simple to reset, and CLF fuses can be quickly replaced.
3. **Completely wired and assembled** starter can be quickly installed. Simply connect incoming power leads and motor-control leads and motor can be put on line.
4. **Air-break contactors** have silver contact tips to give long operating life with a minimum of maintenance.

Write for bulletin GEA-6584 to Section 783-102, General Electric Company, Schenectady, New York.

LOW-VOLTAGE INDIVIDUAL STARTERS

General Electric's complete line of starters is . . .

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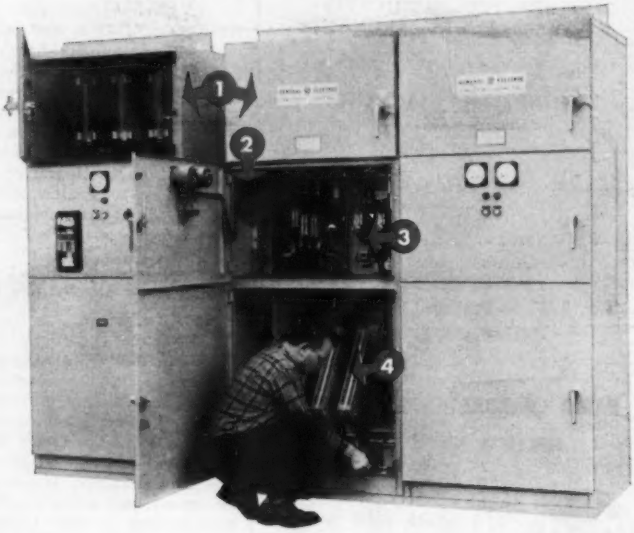
1. **Individual or grouped control** is obtained by installing 30-inch deep Limitamp starters as units or in lineups, mounted back-to-back or back-to-wall with a common power bus.
2. **Ample space for cable entry** is provided at top and bottom of unit. All installation wiring is made to conveniently located terminal boards.
3. **Hinged low-voltage panel** swings out for accessibility. Front-connected components are easy to maintain.
4. **High-voltage contactor** rolls out of enclosure. Low-voltage connections are plug-in type. Tip changing and a-c coil removal are fast and require a minimum of effort and tools.

For more information contact your G-E Apparatus Sales Office, or write for bulletin GEA-6331 to Sect. 783-102, General Electric Co., Schenectady, N. Y.

HIGH-VOLTAGE LIMITAMP* STARTERS

** Registered Trade-mark of General Electric Co.*



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LOW-VOLTAGE MOTOR CONTROL CENTERS

For flexible, grouped control of motors up to 400 hp

1. **All starter units in one structure** eliminates grouping of individual starter enclosures and associated installation expense.
2. **NEMA Class II construction** has factory-wired and tested interconnections. To install, simply connect power and outgoing motor-control leads.
3. **Front connected units** are accessible for speedy inspection and maintenance of wiring and components.
4. **Easily removable starter units** reduce bench maintenance time. Speed latches expedite unit removal; hold units in place when engaged. Components are readily accessible from top, front, and sides when starter unit is removed.

Write for bulletin GEA-4979 to Section 783-102, General Electric Company, Schenectady, New York.

install and maintain

LOW-VOLTAGE CABINETROL* POWER CENTERS

** Registered Trade-mark of General Electric Co.*

For custom-engineered grouped control of motors up to 900 hp

1. **Roomy starter compartments** facilitate routine inspection and maintenance without removal of starter unit from compartment.
2. **Custom engineered controls** are supplied to specific application needs. Complete system is factory-wired and tested. Installation requires only connecting incoming power and motor-control leads.
3. **Easily accessible components** are mounted with ample room for adjustment and maintenance. Spring-latch door provides easy access.
4. **Hinged, full-height rear doors** allow inspection and testing of continuous process equipment without stopping the process.

For more information contact your G-E Apparatus Sales Office or write for bulletin GEA-3856 to Sect. 783-102, General Electric Co., Schenectady, N. Y.

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Development of circuits and equipment in conjunction with missile and navigation systems installations aboard submarines. Requires EE degree with advanced courses and experience in servomechanisms.

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1. 5 years experience on shipboard electrical systems design. For design of electrical power and control systems for prototype nuclear propulsion systems for a marine gas cooled reactor plant.
2. EE, ME or Physics degree required. Responsible for conceptual engineering and systems analysis of large complex devices employing a combination of electrical, electronic, electromechanical, hydraulic and pneumatic systems. Should be familiar with servomechanisms theory, experienced in use of analog or digital computers as a design tool, and have a good grasp of mathematics. Will work on proposal preparations, feasibility studies and execution of hardware contracts.

SERVOMECHANISMS

For engineering design of servomechanisms in both the instrument and multiple horse-power class. Will interpret performance specifications and be responsible for design of a system in accordance with the specifications, including stability studies, and the calculation of other performance criteria.

COMPUTERS

Responsible for conceptual engineering and programming of special purpose digital and analog computers. Should be familiar with system engineering, experienced in programming and check systems for both analog and digital computers, with good grasp of simulation techniques. Requires EE, Physics or Mathematics degree.

CIRCUITS

Responsible for conceptual and production engineering of electronic equipment. Familiar with servomechanisms and analog computer theory. Experienced in use of semiconductors, magnetic amplifiers and vacuum tube circuit elements; good grasp of mathematics; EE or Physics degree.

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PhD in physical sciences required. To be responsible for operations research studies of submarine and anti-submarine weapons systems.

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To arrange convenient appointment, write in confidence to James P. O'Brien, Technical Employment Supervisor.

GENERAL DYNAMICS ELECTRIC BOAT DIVISION

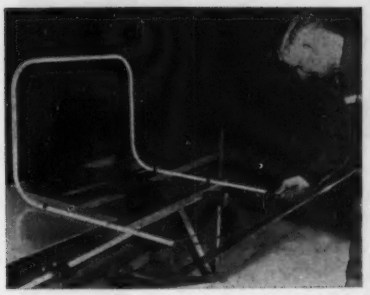
Groton, Connecticut

Industrial Notes

(Continued from page 37A)

Republic Steel Corp. Cleveland, Ohio . . .

A new interior finish called Silverslick, which greatly facilitates the pushing and pulling of wires through its electrical metallic tubing has been developed by the Steel and Tubes Division of Republic Steel



Courtesy Republic Steel

Corp., Republic Bldg., Cleveland, Ohio. It is being used currently in production of the company's "Inch-Marked" electrical metallic tubing.

Van Norman Industries, Inc. New York, N. Y. . .

Van Norman Industries, Inc., 6 Church St., New York, N.Y. has announced that it has acquired working control of the American Pulley Co., in which it has held a minority interest for the last 3 years. It was stated that American Pulley will be continued as a separate company; it is long established in Philadelphia, manufacturing power transmission, materials handling equipment, and pressed metal specialties.

Richardson Scale Co. Clifton, N. J. . .

This company's Philadelphia regional office has been moved to 11 Park Rd., Havertown, Pa. The office handles all the company's business in Pennsylvania, Virginia, Maryland, and Delaware. Mailing address of the new office is P. O. Box 602 The telephone number remains unchanged from HIlltop 6-1308. Headquarters of the Richardson firm, designers and manufacturers of industrial weighing and proportioning equipment and controls, is in Clifton, N. J.

Eitel-McCullough, Inc. San Carlos, Calif. . .

The company's new electron-tube facilities are now in full production at 301 Industrial Way, San Carlos, Calif., as corporate headquarters and manufacturing activity in addition to their plants at San Bruno, Calif., and Salt Lake City, Utah.

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Vast new space and missile projects have created outstanding opportunities in research, development and design at Douglas. Here are some of the areas in which we have immediate openings for engineers and physicists with advanced degrees (B.S. also considered):

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SPACE COMMUNICATIONS — Telemetry system research and development, research in wave propagation in ionized gas, high frequency breakdown and many other areas.

SPACE POWER — Unconventional power research and development to supply power in space stations and on other planets.

LOGICAL DESIGN — Solid state digital circuits as applied to automatic test and firing equipment, utilization of complex switching and logic circuitry, and utilization of computers in detailed circuit design.

ANTENNA DEVELOPMENT — Complete research, advance design and development of antenna and radome systems for use on space vehicles.

For full information write to Mr. C. C. LaVene, Staff Asst. Vice-president, Engineering, Box 620-Q, Douglas Aircraft Company, Inc., Santa Monica, Calif.

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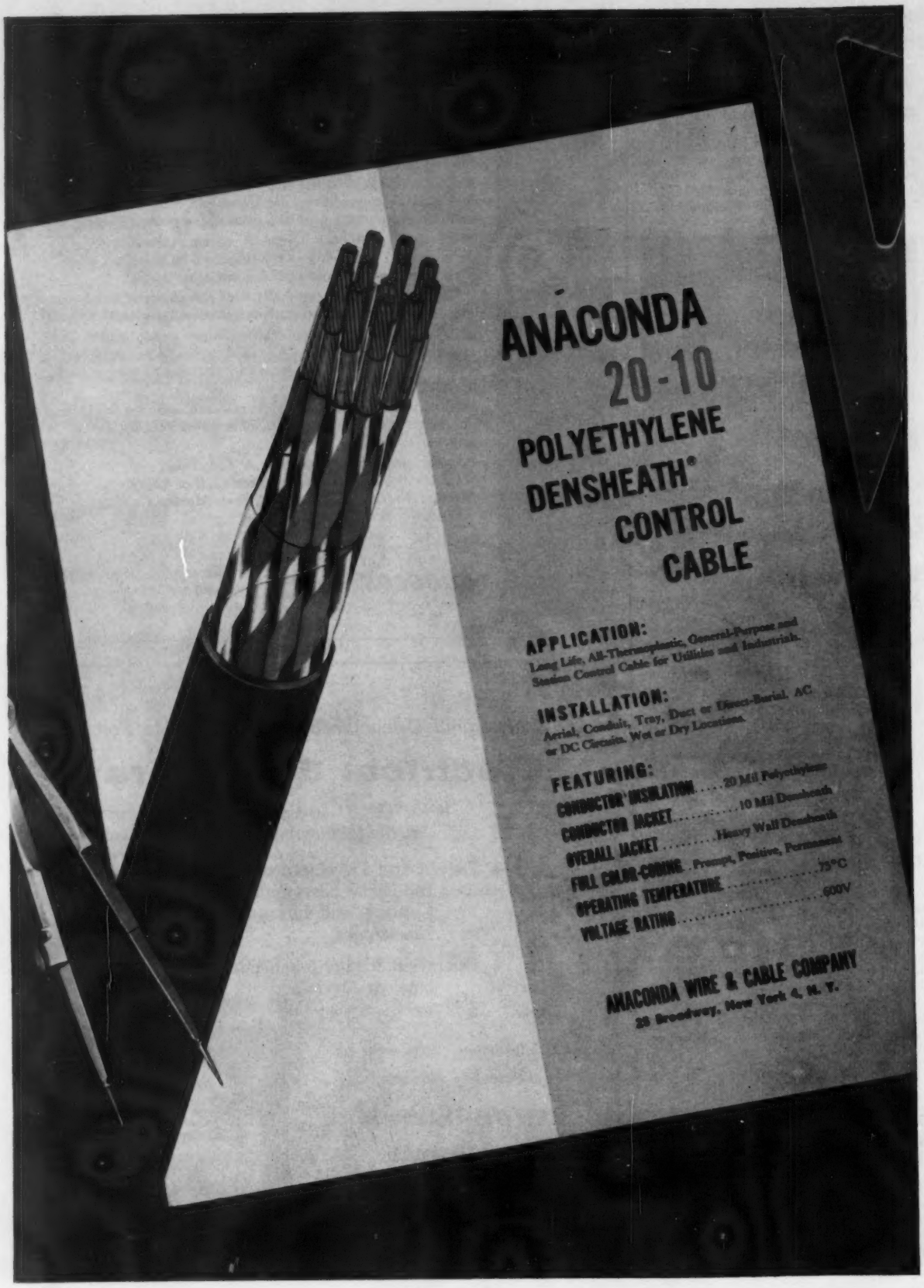
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Long Life, All-Thermoplastic, General-Purpose and Station Control Cable for Utilities and Industrials.
INSTALLATION:
Aerial, Conduit, Tray, Duct or Direct-Burial. AC or DC Circuits. Wet or Dry Locations.
FEATURING:
CONDUCTOR INSULATION ..... 20 Mil Polyethylene
CONDUCTOR JACKET ..... 10 Mil Densheath
OVERALL JACKET ..... Heavy Wall Densheath
FULL COLOR-CODING ..... Prompt, Positive, Permanent
OPERATING TEMPERATURE ..... 75°C
VOLTAGE RATING 600V
ANACONDA WIRE & CABLE COMPANY
25 Broadway, New York 4, N. Y.

ANACONDA OFFERS ONE CONTROL CABLE FOR PRACTICALLY ALL 600-VOLT APPLICATIONS: ANACONDA THERMOPLASTIC 20-10 CONTROL CABLE!

Polyethylene—Densheath* (PVC) construction provides superior features, makes possible new economies and improved service through standardization.

Anaconda—after testing a wide range of designs — recommends 20-10 Control Cable as today's superior all-purpose thermoplastic cable for 600-volt service. Here is a standard control cable for practically every 600-volt application —one that simplifies your ordering, stocking, installing, makes possible new economies in time and money.

Anaconda 20-10 Control Cable has been designed to meet all the exacting requirements for the highest quality control cable. Each conductor is insulated with 20 mils of polyethylene, then covered with 10 mils of Densheath (PVC). This construction combines the full IPCEA recommended insulation thickness (30 mils for 600 volts) with the flame retardance, excellent color coding and abrasion-resistance of PVC.

This composite design results in a control cable that can be used in virtually all 600-volt control applications. It can be installed aerially, in conduits, trays or ducts, and directly buried.

For 1000-volt rating, this same design is recommended, with the thickness of Polyethylene and Densheath (PVC) increased to 30 and 15 mils respectively.

Write for descriptive bulletin DM-5844 for complete technical details on Anaconda 20-10 Control Cable. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

*Reg. U.S. Pat. Off. 59236

ASK THE MAN FROM

ANACONDA®

FOR 20-10 CONTROL CABLE

ANACONDA WIRE & CABLE COMPANY EE
25 Broadway, New York 4, New York

Gentlemen:

Please send me a copy of Bulletin DM-5844 containing full technical information on Anaconda 20-10 Thermoplastic Control Cable.

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Company.....

Address.....

City.....Zone....State.....

Electrical Engineer

(SENIOR)

Challenging opportunity for senior EE possessing supervisory ability. Applicant should have 10-15 years' electric utility company experience in the planning, operation and maintenance of electric utility systems. Must be thoroughly acquainted with all phases of system planning, modern relaying practices, switchgear applications, short circuit studies, system performance calculations, lightning arrester coordination, communications and telemetering.

Salary commensurate with past experience.

Send detailed resume giving age, education, previous experience and salary requirements to:

Box 20
ELECTRICAL ENGINEERING
33 West 39th Street
New York 18, N. Y.

CHIEF ELECTRICAL DESIGN ENGINEER

We are in immediate need of an Electrical Design Specialist for assignment to our Los Angeles office.

Candidate should possess a minimum of 10 years experience in design of power transmission and distribution; lighting layout and design; instrumentation and controls; signal, alarm, telephone, public address and radio systems. Some field experience desirable.

All replies will be kept in strictest confidence.

Forward resume to
Mr. John A. Oliver

HOLMES & NARVER, INC.
849 SO. BROADWAY
LOS ANGELES, CALIF.

Trade Literature...

Measuring Vacuum Tube Microphonics . . .

A 16-page Bruel & Kjaer Technical Review, "Measurement of Microphonics," describing the techniques of exciting and measuring the microphonics of vacuum tubes has been made available. Tube reliability in several environments is considered in evaluation of the test techniques. **B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.**

"Packaged" Clean Rooms Brochure . . .

Pre-fabricated clean rooms delivered to the customer's site ready for erection, are described in a 3-color brochure. Also included is information on custom-built test chambers and special-purpose cryogenic and elevated temperature structures. For a free copy of "Ultra Clean Packaged Environments," write **Moore & Hanks Co., 9702 E. Rush St., El Monte, Calif.**

Bulletin on Raceway Fittings . . .

Bulletin No. *493* on Spang electrical raceway fittings for communication and power distribution systems illustrates new designs combining inconspicuous modern styling with provisions for fast installation and long life including a new square, rimless floor pan that leaves a smooth, unbroken pattern on tile floors. **Underfloor Duct Dept., The National Supply Co., Two Gateway Center, Pittsburgh 22, Pa.**

"Recording Voltmeters and Ammeters" . . .

Described in a new edition of Bulletin *E-111* are one-, two-, and three-pen instruments in wall-mounting, panel-mounting, portable, and pole-mounting models. A compact portable model developed especially for public utility use is featured. Operating principles are explained, models are described in detail, and a list of charts and accessories for use with the instruments is included. **The Bristol Co., Waterbury 20, Conn.**

Servo Motors Catalog . . .

Catalog No. *5,000* lists and fully describes in 20 pages all basic models of Oster's complete line of precision-made servo motors, sizes 8 to 29, for scientific, military, and industrial applications. Included are dimensional drawings, and physical, electrical, and mechanical characteristics. **John Oster Manufacturing Co., Avionic Division, 1 Main St., Racine, Wis.**

Application Procedure Booklet . . .

An application procedure booklet, *85-300*, containing complete instructions for the installation of preformed splices on messenger strands, guy strands, ground wires, and open line wires is available from **Preformed Line Products Co., 5349 St. Clair Ave., Cleveland 3, Ohio.**

Capacitor Catalog . . .

This 46-page general capacitor catalog covers the entire line of tubular, ceramic disc, and subminiature electrolytic capacitors of **Good-All Electric Manufacturing Co., 112 West 1st St., Ogallala, Neb.**

Beryllium Copper Data Sheet . . .

Full information on beryllium copper 10, 25, and 165 alloys for electronic, automotive, appliance, instrument, temperature control, and other applications is given in a 12-page data sheet series. Chemical analysis, physical constants, and mechanical properties of each alloy are described. Heat treating procedures are outlined and illustrated. Working instructions are given for forming, joining, pickling, rolling, and plating. **Pennrold Division of The Brush Beryllium Co., 501 Crescent Ave., Reading, Pa.**

Aluminum Catalog . . .

This catalog has been increased to 31 pages and contains valuable information regarding drawn aluminum tube and extruded aluminum tube and shapes. Included in this edition are special features of the metal, metallurgical aspects, mechanical, physical, and chemical characteristics, tolerance standards and extrusion definitions, along with a statement of scope covering available alloys, length and shipping limitations, and range of sizes. **Wolverine Tube, Division of Calumet & Hecla, Inc., 17200 Southfield Rd., Allen Park, Mich.**

Instrumentation Catalog . . .

This 12-page two-color digital instrumentation catalog describes 32 instruments and accessories including a new transistorized 150-kc frequency-period meter, a new digital voltmeter, and a fast, versatile, digital printer. Other instruments included in the catalog are universal counter-timers, frequency-period meters, frequency meters, time interval meters, inline-inplane readouts, electronic GO–NO-GO gauges, preset counter controllers, and decade counting units. **Computer Measurements Co., 5528 Vineland Ave., N. Hollywood, Calif.**

(Continued on page 46A)

Smaller Panels

WITH SQUARE D *"System-Designed"* RELAYS

CLASS 8501
TYPE DO-22

Write for Bulletin D.
Square D Company,
4041 North Richards Street, Milwaukee 12, Wisconsin

• Square D relays are available for both AC and DC systems—with up to 10 contacts—in both electrically and mechanically held forms. Timing relays are also available in AC and DC versions—with timing intervals from 0.2 second to 3 minutes.

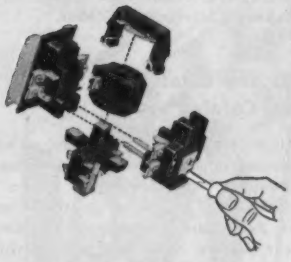
Both relays and timers give you these important advantages:

Require less panel space • Relays are only 3″ wide, range in height from 3¼″ to 5″. Timers are just 2⅝″ x 4³⁄₁₆″ or 2½″ x 7²¹⁄₃₂″. Mechanically held relays require no extra panel space.

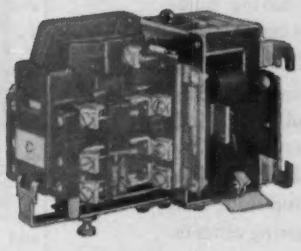
No mounting problems • All Type A timers and Type D relays have identical mounting hole dimensions.

Easy wiring • Choose either pressure wire connectors or slip-on connectors for all terminals.

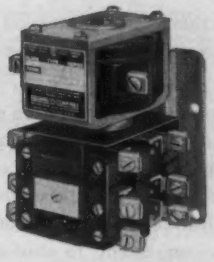
Long life • Balanced construction reduces wear on single moving part. Epoxy-resin molded coil operates cooler, virtually eliminates coil burnout.



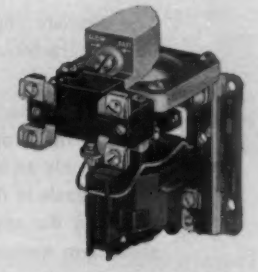
Disassembly from front in 20 seconds makes Square D Type D relays easiest to maintain



Convert any Square D Type D relay to mechanically held with easy-to-use attachment



DC relays have contact arrangements and mounting hole dimensions identical to AC

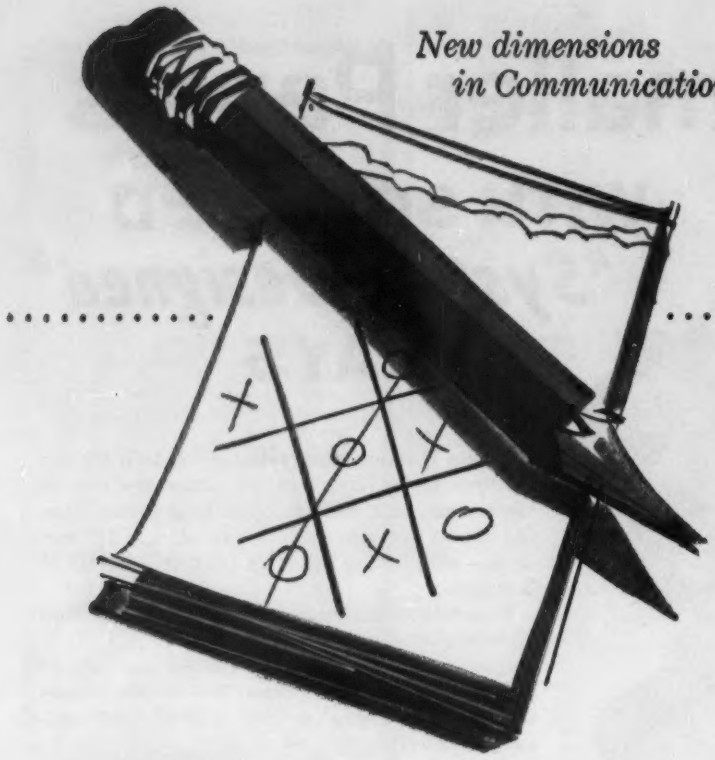


Timing relays convertible from on-delay to off-delay, using only a screwdriver

Square D offers the broadest line of relays, starters and accessories for all types of control systems

SQUARE D COMPANY

New dimensions in Communications



3. EXPLORATION OF ORDER

GENERAL TELEPHONE LABORATORIES has initiated a long-range program of research focused on the development of a "high-speed" communications network capable of accommodating numerous modes of signaling.

The ultimate objective is a transmission grid having functional characteristics approximating those of the central nervous system.

One project now under study involves an electronic switching complex that would provide access to lines and would hold circuits only so long as there existed a continuity of logical-order signals in the proper space reference. This approach is based on the application of time-division multiplexing and short-term memory components to solid-state gating circuits.

This is but one phase of our work in providing research and design support for Automatic Electric and other subsidiaries of General Telephone & Electronics Corporation.

We offer permanent positions to Physicists and Engineers with experience in solid-state circuitry, digital data transmission, computer circuitry, memory systems, and electronic packaging. For an appointment, write in confidence to Mr. Robert Wopat, President, General Telephone Laboratories, 100 Wolf Road, Northlake, Illinois.

General Telephone Laboratories

GENERAL SYSTEM

Trade Literature

(Continued from page 44A)

Booklet on Insulation for Rewound Motors . . .

An 8-page booklet on a new insulation for rewound motors called "New Super Coilife Gives You Extra Motor Life" lists the industry applications for which the solventless epoxy encapsulation is best suited, and outlines its physical and chemical properties. For a copy of booklet *B-7622*, **write Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.**

Gold Plating and Hydrogen Purification Data Files . . .

Entitled "Gold for Industry and the Arts," a data file that answers scores of questions about the uses and methods of gold plating and many other pertinent facts about the industrial and decorative applications of the precious metal has been prepared by the Chemical Division of Engelhard Industries, Inc. Also available is a description of the Chemical Division's new hydrogen-purifying unit that produces ultra-high-purity hydrogen by the Engelhard Palladium Diffusion Process. This information includes the sequence of operations of the unit and a schematic diagram. **Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J.**

Recording Systems Booklet . . .

A 16-page booklet entitled "New Concepts in Recording—for Military, Industrial, and Scientific Applications" describes various methods of recording, and identifies and defines those circumstances under which direct writing recording systems provide maximum benefit to military and industrial users. **Brush Instruments, 37th and Perkins, Cleveland 14, Ohio.**

Motors and Rotating Devices Catalog . . .

A complete line of small a-c motors and rotating devices according to military and commercial specifications is shown in this catalog. The firm manufactures blowers, axial fans, cooling cabinets, servo and gear motors, induction and synchronous motors, torque motors, permanent magnet alternators, and motor generators. **Rotating Components, Inc., 267 Green St., Brooklyn 22, N.Y.**

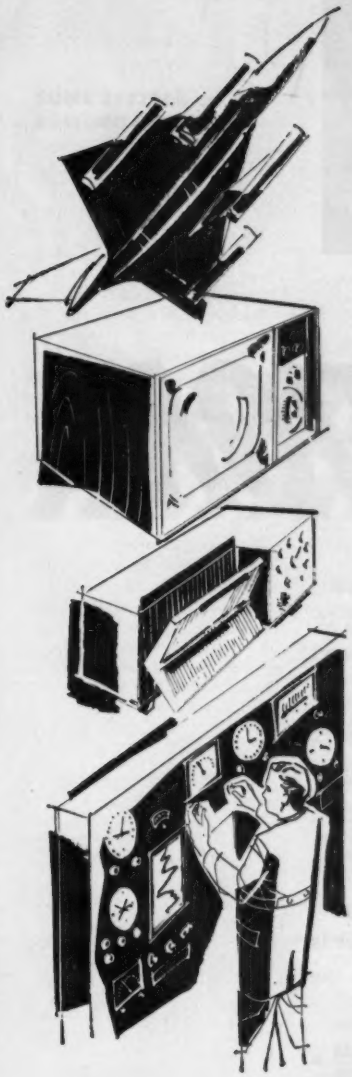
Facilities Manual . . .

A manual describing subcontract facilities for electrical, electronic, and mechanical equipment, complete from product design and development to testing, packaging, and shipping of the finished product, has been prepared by **The Paraplegics Manufacturing Co., Inc., 10068 Franklin Ave., Franklin Park, Ill.**

New steels are born at Armco

Improve Efficiency, Cut Cost of High Frequency Components

with Armco Thin Electrical Steels



AIRCRAFT
Servo-mechanisms
Motors
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Converters

TV
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CONTROL
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High permeability silicon steels in 1 to 7 mils thicknesses lower energy loss, permit reductions in core dimensions and weight of equipment.

Armco Thin Electrical Steels provide a unique combination of exceptional magnetic and physical properties that create opportunities to produce better high frequency electrical and magnetic equipment at less cost.

In addition to exceptionally high permeability and low hysteresis loss, assured by precise processing and control, these special Armco Steels give you:

High lamination factor and gage uniformity. Smoothness, flatness, close tolerances, and edge-to-edge gage uniformity mean maximum efficiency and most effective use of core material, simplify fabrication.

Minimum interlaminar loss. Armco processing produces a thin, smooth insulation of high resistivity that is not affected by the recommended stress-relieving anneal.

Assured results. Magnetic properties are fully developed at the mill. You design with extensive data that permit most efficient balance of performance and cost.

Three different grades enable you to make maximum use of the advantages of Armco Thin Electrical Steels:

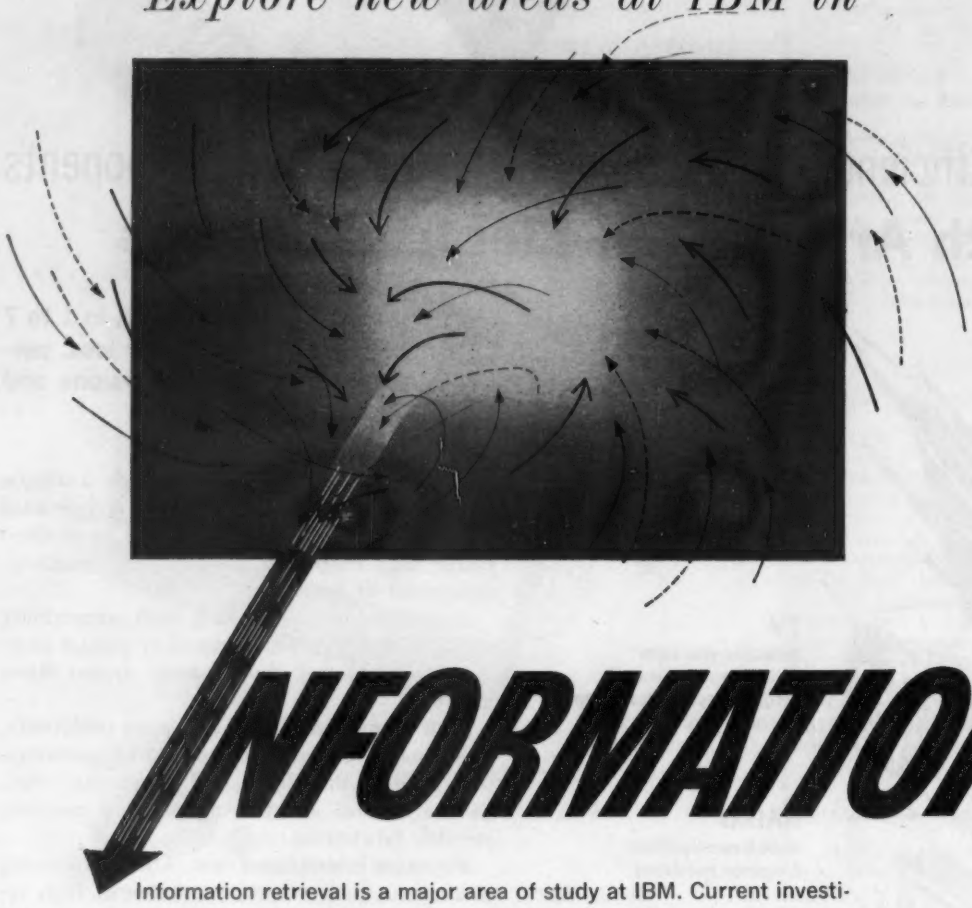
Armco TRAN-COR® T—7 and 5 mils, non-oriented
Armco ORIENTED T—4, 2, and 1 mil
Armco ORIENTED TS—4 mils, super-oriented

For more information on the applications of Armco Thin Electrical Steels or design data, write Armco Steel Corporation, 2319 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Explore new areas at IBM in



INFORMATION

Information retrieval is a major area of study at IBM. Current investigations may lead toward such benefits as the instant accessibility to knowledge in the Library of Congress—or toward a system which can translate any of the earth's languages into English in real time.

Problems in information retrieval have defined entirely new concepts for the design of storage, input-output and "memory" units—achieving far greater capacities than any known today. These facilities will provide for the handling of the tremendous amount of updated information needed by business, science and government. With extremely rapid accessibility to vast amounts of information electronically stored, industrial and research efforts can be materially expedited. IBM needs engineers and scientists with the vision and the ability to pave the way to tomorrow.

You will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

CAREERS AVAILABLE IN THESE AREAS

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Circuit design & research
Component engineering
Human factors
Inertial guidance
Information theory
Logic
Operations research
Optics
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Real-time engineering
Semiconductors
Solid state development
Systems analysis & design
Transistor device design

QUALIFICATIONS

B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics or Mathematics—and proven ability to assume a high degree of technical responsibility in your sphere of interest.

SOME TYPICAL ASSIGNMENTS

704 PROGRAMMER ANALYST to study data flow diagrams and write differential equations of a circuit diagram; to investigate analog and digital real-time control systems, using high-speed electronic digital and/or analog computers. Must be familiar with variable length alphabetic data, transforms, numerical analysis.

RETRIEVAL

COMPUTER OR SYSTEMS ENGINEER, MATHEMATICIAN OR PHYSICIST to design advanced computer, and work on development of new information retrieval program. Must have strong interest in transistor circuit design or in logical or systems applications of solid state circuitry.

MATHEMATICIAN to do programming of information retrieval research and plan construction of advanced systems. Will play an active part in automatic programming techniques, numerical analyses, criteria selection, probability and game theory.

SENIOR ENGINEER, MATHEMATICIAN OR PHYSICIST interested in systems; experienced in operations research, communications, missiles or radar.

For details, write, outlining background and interests, to:

Mr. R. E. Rodgers, Dept. 550G
IBM Corporation
590 Madison Ave.
New York 22, N. Y.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

New Products

(Continued from page 33A)

New Universal Impedance Bridge . . .

Type *1650-A* impedance bridge is a highly accurate instrument for the measurement of the inductance and storage factor Q of inductors, the capacitance and dissipation factor D of capacitors, and the a-c/d-c resistance of all types of resistors. Completely self-contained and portable, the bridge is battery-powered and has a transistorized oscillator and detector. The measured quantities R, L, C, D, and Q are indicated directly on dials with logarithmic scales. **General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**

Static Protective Relay . . .

Departing from the 50-year-old practice of using mechanical induction discs, this new transistorized protective relay features many advantages of a static device. It is one third the size of its predecessors, is less sensitive to frequency variations, takes somewhat longer to operate on decreasing currents and acts more quickly on increasing currents, and has greater reliability due to extensive temperature range and longer life. Relatively short resetting time is another advantage in cases where shifting loads in an electrical distribution system require close setting of relays. All components are mounted on a printed circuit board using a plug arrangement. **Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.**

Hot Switch . . .

A new S.P.D.T. limit or sensitive switch will maintain its operating characteristics during long exposure to temperatures as high as 800 F. It was designed for precision applications on aircraft and guided missiles, and for use in furnaces, ovens, and other high-temperature environments.. The *21135-1* can be used where extreme corrosion conditions are present because all components are made of inorganic and nonplastic materials. **Metals & Controls Corp., Attleboro, Mass.**

Industrial Preset Controller . . .

Designed specifically for heavy duty industrial applications, these transistorized units operate directly from all types of sensing devices and have provision for a wide range of optional outputs. Preset controls range from 0 to 180,000 counts per minute. Numerical readout consists of either glow counter tubes or Nixie in-line indicators. Among the many applications for this device are counting, measuring, and control for automatic cutting-to-length, batch counting and sequencing, and automatic machine tool positioning. **Dynapar Corp., 5150 Church St., Skokie, Ill.**

(Continued on page 55A)

75 YEARS: PROLOGUE TO THE FUTURE

The history of today's electrical-electronic industry and the great firms that compose it is the history of ELECTRICAL ENGINEERING. The men who founded these great companies used the monthly journal of the Institute as an engineering forum, to report their discoveries, discuss their theories, develop industry standards.

And here, in the advertising pages of ELECTRICAL ENGINEERING, companies announced their discoveries and developments... and promoted their products.

Today, ELECTRICAL ENGINEERING plays the same role: it is the place where engineers share ideas and information with their colleagues. ELECTRICAL ENGINEERING is written by engineers for engineers: it's the place advanced information is published first... the place where engineers discuss applications and methods they have found effective . . . where electrical engineers throughout industry are kept informed on new developments by the men and companies responsible for them.

KEEP UP WITH THE FUTURE . . . YOUR FUTURE

. . . by keeping up with ELECTRICAL ENGINEERING. You'll find every issue during this important 75th Anniversary year filled with first reports of new and significant developments in every branch of the electrical-electronic industry—with practical ideas and information about products and services you can put to profitable use in your work today, and tomorrow.

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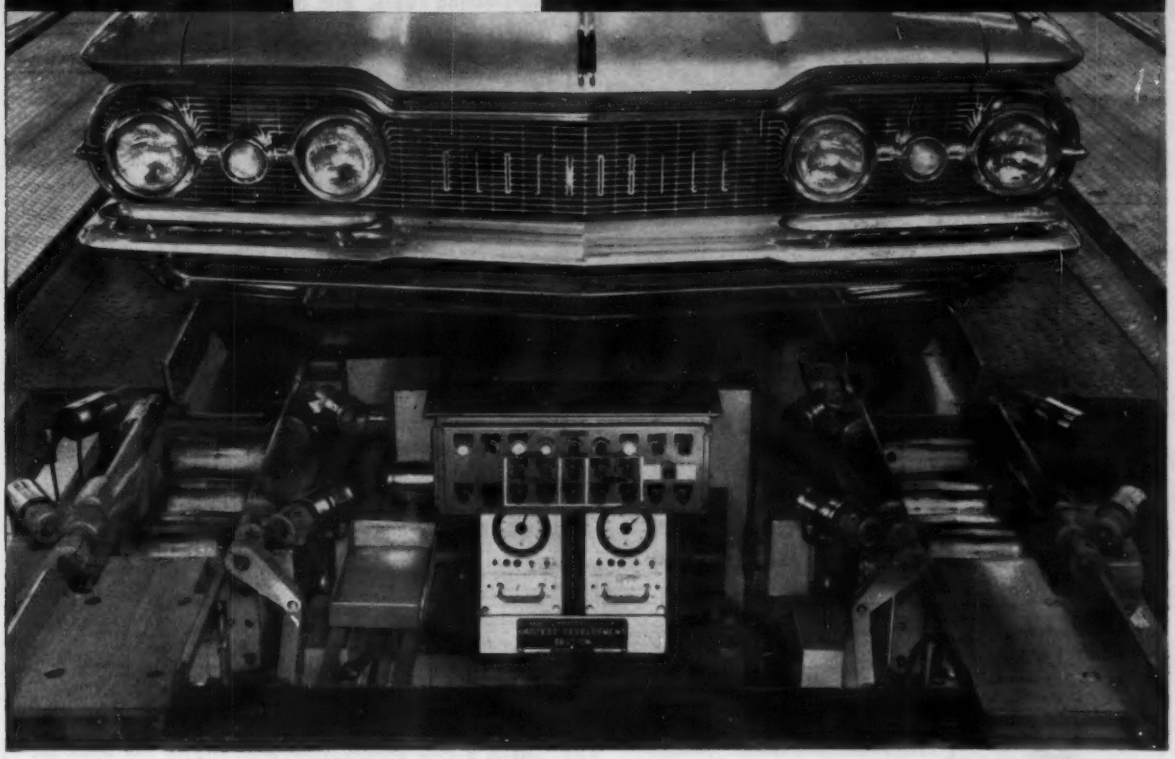
You'll find it well worth your while to take extra space in these important Jubilee Year issues of ELECTRICAL ENGINEERING—to sum up the accomplishments of *your* company for the more than 50,000 engineers who are putting electricity to work throughout industry. To report on what *your* products have to offer in practical engineering applications—in the products engineers are already planning, designing and developing for today's and tomorrow's markets.

The Inquiring Mind at Oldsmobile



no. 9 OF A SERIES

OLDSMOBILE "TOES THE MARK" ... ELECTRONICALLY!

Oldsmobile Engineering Leadership sets the industry pace with a unique electronic wheel alignment device that dynamically computes "toe-in" measurements for precision steering and handling.

Handling and steering ease depend upon precise, minute measurement and control of front wheel alignment. Because wheels have a tendency to "toe-out" when in motion, they must be adjusted for a slight amount of "toe-in" to eliminate "wheel fight", wander and undue tire wear.

To meet the requirement of rapid, yet extremely accurate measurements on the production line, Oldsmobile engineers developed an electronic computor—a *linear-differential-variable transformer*—that dynamically and accurately measures the average amount of toe-in within .030 inches. As the car is brought into position, the wheels are rotated by rollers to simulate actual driving conditions and to eliminate errors caused by variations in tire run-out. By watching the visual gauges, an operator can quickly make the necessary adjustments to the steering linkage.

By using the most up-to-date electronic measuring techniques in engineering and manufacturing, Oldsmobile is able to offer safe, accurate steering and handling . . . a controlled, comfortable ride. Visit your local Oldsmobile Quality Dealer, take a ride in a '59 Oldsmobile and see why it's the value leader of its class!

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for St. Louis, Cleveland, Detroit, Baltimore, San Francisco, and El Paso, Texas. Prefer graduate Chemical, Electrical, or Mechanical Engineers with two or three years industrial experience. Trainees will receive intensive training course with daily classroom instruction at Waterbury factory before assignment to district office. Mail reply to:

H. E. Beane, Vice President,
The Bristol Company,
Waterbury 20, Connecticut.

TRANSMISSION ENGINEER

Staff position for graduate Electrical Engineer with experience in transmission line design, sag and tension calculations, economic studies, cost estimating, selection of conductors and structures, preparation of specifications and evaluation of quotations of suppliers. Salary open. Headquarters New York City.

Box 21
Electrical Engineering
33 West 39th Street
New York 18, New York

Proceedings of the Computers in Control Systems Conference
(May 1958)

THE PAPERS PRESENTED at this conference held October 16-18, 1957 in Atlantic City, N. J., by scientists from the United States, and representatives of the USSR, France, and England, were intended to spotlight the present development in the use of computers in the design process, and as elements of feedback control systems.

It is felt that this international interchange of information will be mutually advantageous to visitors to the conference from abroad, as well as to those from the United States.

The 189-page publication of 31 papers was sponsored by the Feedback Control Systems Committee, AIEE, the Professional Group on Automatic Computers, Institute of Radio Engineers, and the Instruments and Regulators Division, American Society of Mechanical Engineers. Price of publication *T101* is $3.50. Send to:

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
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Recent graduate with up to two years experience. Supervise and coordinate electrical maintenance, installations, and design in a large pharmaceutical manufacturing firm which has been continuously expanding.

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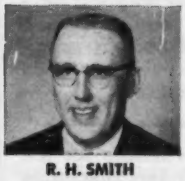
West Virginia—Eastern New York State

• Must know interior electrical distribution. To call on engineers, architects, contractors, distributors and major power users. Graduate Engineer or equivalent to qualify. Well established nationally known company, leader in the industry. Long range profitable opportunity. Please submit complete resume with picture to:

BOX 24
Electrical Engineering
33 West 39th Street
New York 18, New York

Smutting caused generator trouble

This spitfire is a lady now... thanks to the NATIONAL brush man!



R. H. SMITH

Smut piling up on commutators caused constant arcing in the 1250KW generators of this large smelting plant. *The reason:* improper brush selection, says "National" Carbon Brush Man R. H. Smith.

After analyzing work loads, Ron recommended "National" brush grade SA45. *Result:* no further arcing and improved commutation. This results in far easier maintenance.

Ron Smith is one of many "National" Carbon Brush Men serving industrial brush users all over the U. S. A. Their technical experience — plus "National" long term brush research — make them your logical consultants on any brush problem.

Call your local "National" office or write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

UNION CARBIDE

NATIONAL CARBON COMPANY • **Division of Union Carbide Corporation** • ***30 East 42nd Street, New York 17, N. Y.***

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John Mitchell, Asst. Chief Engineer: Mobile and Portable Communications Products

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Power Supply for Resistance Welding Machines
(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940-1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

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New & Improved Products

(Continued from page 49A)

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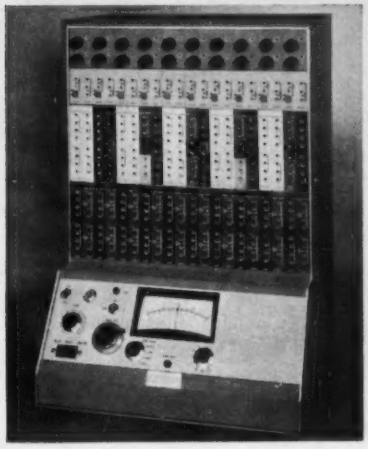

multiple calculations to arrive at the best possible design combination. Applications range from the transient performance of electrical machinery, electronic circuits, and the theory of automatic control to aircraft and missile, chemical and petroleum, and automation component and system design. **Electronic Associates Inc., Long Branch, N. J.**

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Symposium on Research and Education

Special Publication S-82 comprises of four papers that were presented at the AIEE Winter General Meeting, New York, N. Y., February 2, 1956, and is sponsored by the AIEE Committee on Research and Education. The papers deal mainly with the problems of the utilities and the industry in general in attracting young engineers into the field.

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This conference was planned to provide a review of the progress made in instrumentation technology. Publication T-113 is the record of the conference held at Philadelphia, Pa., April 20-21, 1959. Sponsored by the Recording and Controlling Instrumentation Committee of the AIEE, the 279-page publication contains 31 of the papers presented at the meeting which was divided into the following sessions:

1. **Engineering Education for Instrumentation**
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SUPERINTENDENT — ELECTRIC POWER, LIGHT: E.E., C.E. 18 yrs—superintendent, design, rate structure, construction, bids, costs, production and distribution, systems. 2 years' layout and installer plant distribution systems, power plant for saw mill. 9 years' lineman, production and distribution for utility. Salary open. Prefer West Coast or Any Other. ES(M)-1794.

DESIGN — INSTRUMENTATION, PROCESS, POWER: E.E. 4 years' design schematics for power plant constr, superv constr of test labs. 4 years' research, design of power plants & distribution stations. $750. Prefer San Francisco. ES(M)-325.

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DESIGN, MAINTENANCE—PULP, PAPER, INDUSTRIAL: E.E. 8 years' supervisor of electrical maintenance of air conditioning equipment, design and installation of electrical equipment, field installation for pulp and paper mill, manufacturing. 6 years' design substations for utility; design, estimates, budgets, power systems, lighting for pulp and paper manufacturer; design for shipbuilding. 1 year panel construction and transformer assembly for manufacturer. $915. Prefer Northwest, West. ES(M)-1357.

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APPLICATION—ELECTRICAL POWER: E.E. 3 years' experience network analyzer on electrical utility power company problems and development of servo mechanisms and printed circuits for laborator. 1 year telephone technician. 9 months quality control and standards for mill. $6000. Prefer California or Foreign. ES(M)-1671.

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(Continued on page 64A)

Completely Revised, October 1956 Issue

Electric Power Distribution for Industrial Plants

(RED BOOK)

No. 952

The purpose of this publication is to bring to the attention of engineers, owners, and plant management the important features of well-designed electric distribution systems that result in satisfactory performance of utilization equipment and efficient operation of the plant; it covers the features of the electric distribution systems which are applicable to most types and sizes of industrial plants. It sets forth the elements of the distribution system both as to what to do to accomplish desired results and the reasons for them. It does not explain in detail how to accomplish the final results.

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Companion Publication (Also October 1956)

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No. 953

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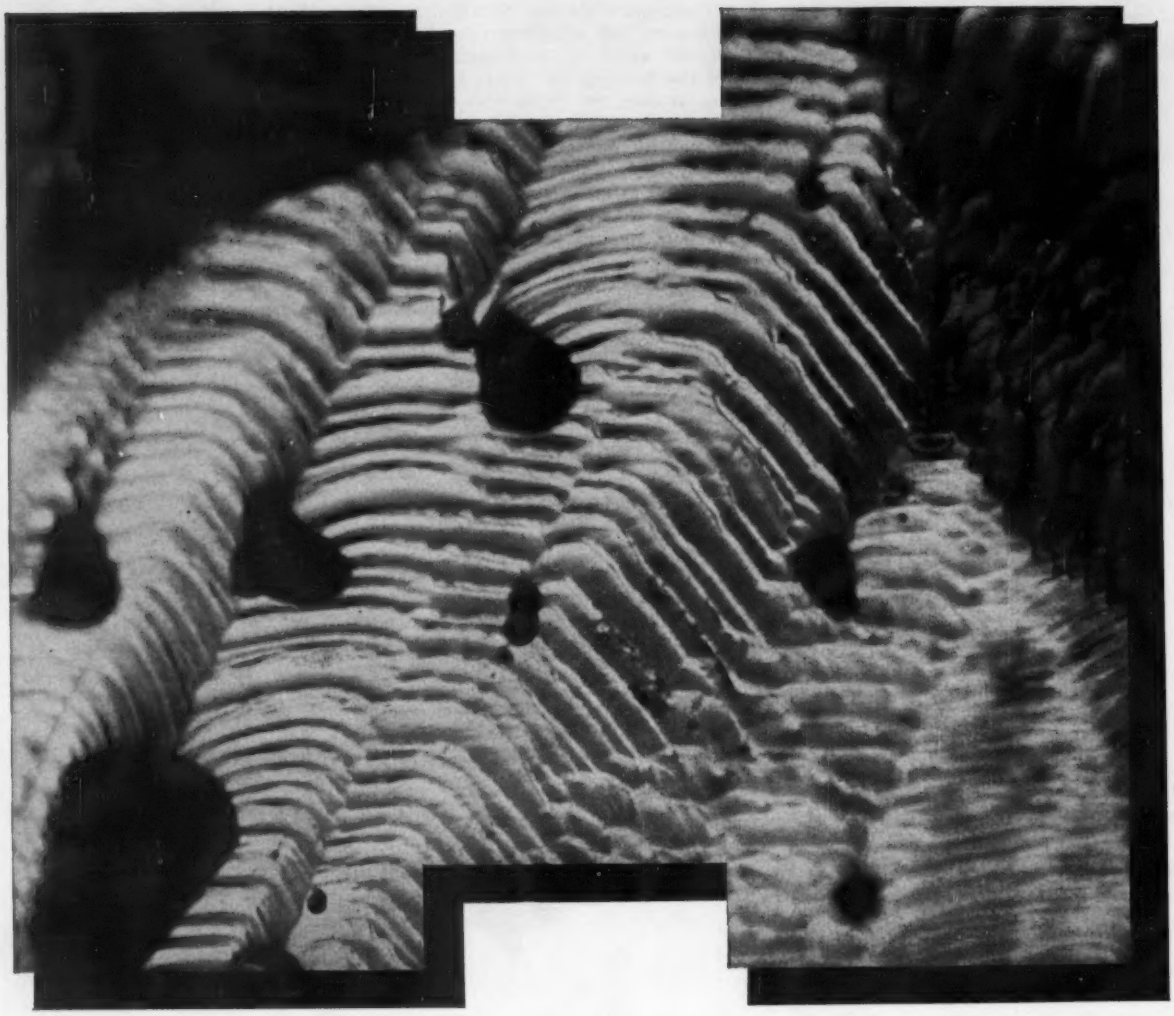

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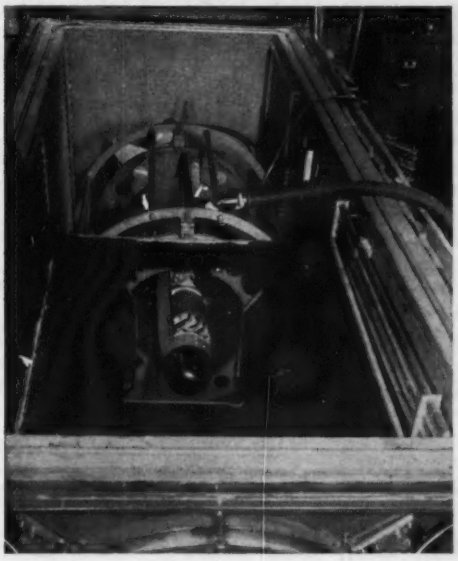

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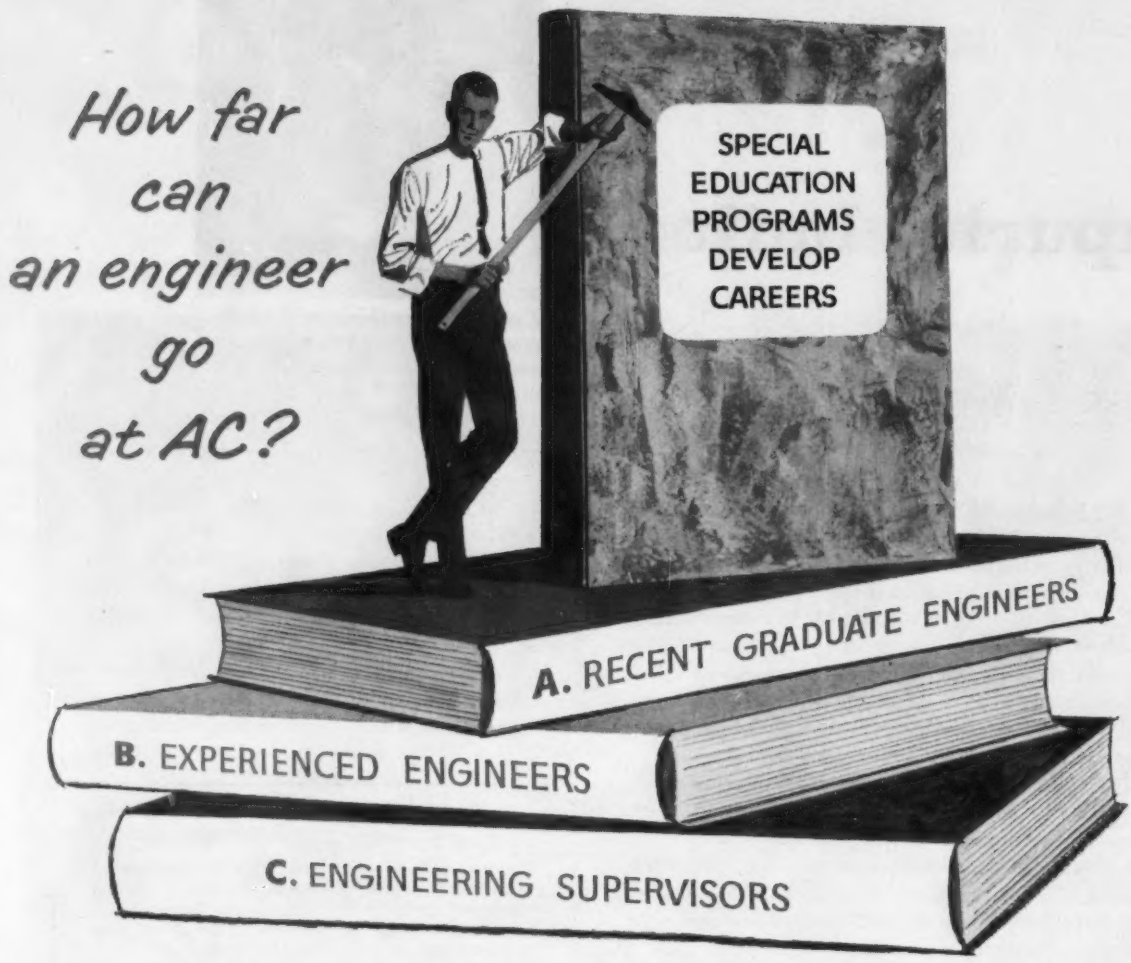
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Personnel Service, Inc.

(Continued from page 58A)

2 years Army. 1 year training, heavy electrical machinery manufacturer. $9500. Any location. ES(M)-629.

DESIGN—CONSULTANT OR CONTRACTOR: E.E. 1 year electrical design electronic transformers to customers specification for manufacturer. 3 months engineering aide on design of substations for public utility. $500. Prefer San Francisco Bay Area. ES(M)-1100.

DESIGN, DRAFT, MAINTAIN — POWER HOUSE, CHEMICAL PLANTS: 6 years' design light, power, instrumentation for chemical plants and mines. 1 year electrical superintendent for steam generating station. 20 years' general foreman, and practicing electrician on generator station building for electrical contractors. $600 up. Any location. ES(M)-790.

Positions Available

ELECTRICAL ENGINEER, B.S.E.E., with power option; with five to ten years' experience, for staff position on design, development and layout wiring for new plants and rehabilitation of old plants in food process industry. Considerable travel. Salary, $8500-$10,000 a year. Headquarters, southern New Jersey. W7350.

ASSISTANT PROFESSOR, graduate electrical, with three to five years' industrial and/or teaching experience, to teach basic and advanced industrial electronics. Salary, $6020-$7250 for calendar year with a minimum of one month's vacation; extra compensation for evening school instruction. Location, New York suburban area. W7363.

ENGINEERS. (a) Senior Electronic Engineers, graduates, with five years' experience in circuit design for computer type circuits, such as storage registers, frequency dividers and basic flip-flop circuits. Must be capable of handling all phases of a development program for military agencies. Background in semiconductor circuitry as applied to above preferred. Salary, to $15,000 a year. (b) Junior Electronic Engineers, graduate electrical, with one to three years' experience in electronic circuit design for transistor and/or computer type circuits; design and testing of military equpment. Salary, to $9000 a year. (c) Mechanical Engineers, graduates, with three to five years' experience in telecommunication field; must have background in packaging of electronic equipment to military specifications, including printed circuit design, shock vibration and environmental tests. Salary, to $13,000 a year. Location, lower Connecticut. W7365.

PLANT MANAGER, electrical graduate, with experience in similar capacity, preferably with a precision instrument manufacturer, optical instruments, aircraft instruments. Knowledge of standard costs and engineering. Salary, $15,000-$18,000 a year. Location, New York suburban area. W7370.

ELECTRONICS ENGINEER, B.S. or M.S. in E.E., heavy in mathematics, digital experience; to carry out error analysis on airbourne digital computers. Involves DDA and GP programming simulation of flight profiles on inputs for test programs. Salary, $10,400-$12,000 a year. Company pays placement fee. Location, upstate New York. W7372(a).

ENGINEERS, B.S.M.E., B.S.E.E.: graduate degree desirable. (a) Senior Designer with five to ten years' experience in the design of precision mechanisms and power control devices. Knowledge of aircraft hydraulic practices, materials and very close tolerance manufacturing methods of prime importance. Must be capable of supervision of lavout, detail drafting and evaluation testing. (b) Design Group Supervisor to supervise a design-drafting department from establishment of technical standards to personnel administration. Must have good appreciation of precision instrument design, considerations and manufacturing techniques. Knowledge of high pressure hydraulics and aircraft components desirable. Five to ten years' experience required. (c) Production Engineering Group Supervisor with four to six years' experience in coordinating technical aspects of manufacturing of precision controls devices. Group workload includes negotiation of customer specifications; definition of assembly and test criteria, procedures and equipment; analysis and correction of production problems and initiation of design changes. Salaries, $9000-$14,000 a year to start, plus profit sharing. When submitting applications indicate current salary. Location, upstate New York. W7374.

ENGINEERS, B.S.M.E., B.S.E.E.: graduate degree desirable. (a) Environmental Test and Reliability Engineer with three to five years experience in environmental and qualification testing of airbourne devices. Should have good appreciation of mechanism reliability considerations and techniques of testing to establish reliability. Must be capable of planning and supervising test programs, analyzing test results effectively and working with designers to correct product deficiencies. (b) Development Engineer, experience in the theoretical design, analysis and experimental development of precision control devices. Should combine ability to work with practical hardware and to apply feedback control theory. Familiarity with electro-hydraulic servomechanisms highly desirable. Salaries, $9000-$14,000 a year to start, plus profit sharing. When submitting applications indicate present salary. Location, upstate New York. W7375.

SENIOR ENGINEERS for Nuclear Power Engineering Department. (a) Head Reactor Engineer, advanced technical degree required; Ph.D. desirable; several years' experience in nuclear reactor science and engineering necessary, plus experience in technical administration. Will supervise section responsible for reactor analysis, reactor experiments, thermal and hydraulics, mechanical core design and mathematics. (b) Chief Project Engineer, advanced degree desirable; must have several years' of direct line supervisory experience of engineering projects, preferably nuclear. Will administer and execute all projects in accordance with approved schedules and prepare and submit proposals. Submit complete resume and salary requirements. Location, upstate New York. W7380.

ENGINEERS. (a) Technical Editor to process reports, papers and proposals in nuclear engineering department. Will establish standards and issue instruction material on format and style of technical documents. Two to three years' technical editing experience required. (b) Publications Engineer to write operating, maintenance and training manuals for water nuclear power plants. Familiarity with general instrumentation systems and the operation of a conventional type power plant are desirable. Some experience with maintenance of pumps, heat exchangers, turbine generators, valving, etc. required. Two to five years' experience in preparing technical publications from blueprints and engineering data necessary. Submit resumes and salary requirements. Location, upstate New York. W7381.

PHYSICIST OR DEVELOPMENT ELECTRICAL ENGINEER, senior or project level. Master's degree preferred. Work will include advanced R & D in fields of UHF and microwave apparatus. Salary, $10,000-$14,000 a year. Location, New York suburban area. W7382(a).

SALES TRAINEES, recent or near graduates in electrical, mechanical or metallurgical engineering preferred, for national organization supplying materials and components to the electrical and automotive industries, particularly for instruments, appliances and control devices, both thermostatic and electrical. Training and indoctrination period. Salary, $5200 a year to start. Location, New Jersey. W7385.

ENGINEERS. (a) Senior Electric Design Engineer, graduate, with experience in design of transformers (pulse transformers and line-type modulator) and pulse forming networks. Practical knowledge of drafting practices and equipment, methods engineering, production planning, etc. Salary, $7000-$10,000 a year. (b) Product Development Engineer, graduate electrical or mechanical, with a minimum of five years' experience, for product development work on wiring devices. Duties will also include checking designs of other engineers and coordinating development projects. Salary, to $8000 a vear. (c) Product Engineer, graduate mechanical, electrical or industrial, with supervisory potential and/or experience. Duties will be with a new department involving solderless multiple contact connectors. Experience with metal stampings, screw machine parts, die castings desirable. Salary, to $7800 a year. Location, western Pennsylvania. W7395.

ELECTRICAL ENGINEER for short circuit studies, calculations of relay settings and analysis of relay operations; should be able to operate a DC calculating board; with background of public utility experience in system protection. Location, South America. F7402.

ELECTRONICS ENGINEER, B.S., with two to three years' experience in pulse techniques and transistors, to design and develop nuclear instrumentation in laboratory. Salary, $8000-$10,000 a year. Location, New York, N.Y. W7406.

ENGINEERS. (a) Project Engineer to take full responsibility for engineering problems occurring in such products as filters, filter networks, chokes, delay lines, power supplies, specialty transformers and other subassemblies used in electronic control equipment. Some knowledge of manufacture and detailed knowledge of the practical aspects of such engineering. Salary, $9000-$12,000 a year. (b) Technical Writer with background in physics or electrical engineering. Will be responsible for the preparation of technical manuals and reports on military electronic gear used by the U.S. Navy. Salary, to $9000 a year. Company will pay placement fees and will move household goods. Location, Illinois. W7409.

SALES ENGINEER, graduate electrical preferred, with two to five years' successful on-the-job performance, preferably in the electronics field (communications, broadcasting, CAA, etc.). Sales experience preferred but not essential. Will call on utilities, government offices, police departments, fire departments, and large corporations as representative for recording machine division of company. Training at main plant. Some travel in southeastern section of the U.S. Salary, from $8500 a year; all expenses paid; fringe benefits. W7417.

RESEARCH ENGINEER OR PHYSICIST, M.S. in physics or B.S. with some experience, preferably in semiconductor electronics, and ability to do original work. Will undertake applied research and development work on solid state and semiconductor devices. Will participate in rapidly expanding development programs in a growing physical research laboratory. Salary open. Location, metropolitan New Jersey. W7422.

ELECTRICAL ENGINEER, graduate, with at least ten years' hydro-electric transmission, distribution and sub-station design and construction experience. Knowledge of Spanish desirable. Location, South America. F7429.

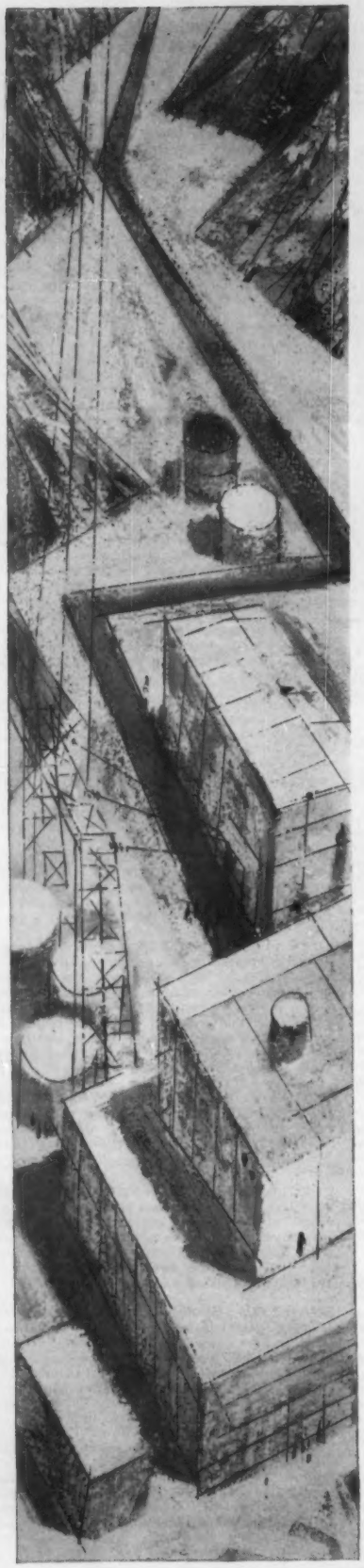
OPERATING ENGINEER, mechanical or electrical graduate, or equivalent, with utility or large industrial high pressure steam generating equipment experience, to test and start up new steam power stations or special projects. Marine experience not suitable. Must be citizen and available for assignment to various locations in U.S. Salary, $8500-$10,000 a year. Headquarters, New York, N.Y. W7435.

SENIOR ELECTRONIC ENGINEER, electrical graduate, with a minimum of five years' experience in instrument circuit design. Salary, $10,000-$12,000 a year. Location, Long Island, N.Y. W7441.

ELECTRICAL TEST ENGINEER, graduate electrical, with one to two years' electric experience, to work on testing problems, examining marine tubes and tube mills through eddy currents. Salary, $8000 a year. Company will negotiate placement fee. Location, New York, N.Y. W7446.

ENGINEERS. (a) Senior Engineer, Automotive Division, graduate mechanical or electrical, with three to five years' experience in design for mass production of industrial controls—relays, small switches or solenoids. (b) Senior Engineer, Consumers' Products Division, to conceive and design new products, watch costs in air moving devices, i.e. fans, ventilators and other new consumer products or appliances. (c) Senior Engineer, Motor Division, for research and development in the manufacture of fractional hp motors. Could have experience in any traffic appliances but a keen interest in small motor design. Salaries, $8500-$11,000 a year. Company will pay placement fees and moving expenses. Location, New York State. W7448.

(Continued on page 66A)



Engineering Analysis Positions

Sodium, Organic, Special Purpose and Research Reactor Programs

Rapidly expanding reactor development programs have provided additional challenging assignments at Atomics International. AI's modern headquarters and plant facilities, located in the San Fernando Valley of Southern California, have become a world-wide center of nuclear reactor development. Here, qualified scientists and engineers have a sound future and unlimited opportunities to advance. Currently, openings exist in:

Reactor Engineering. Analysis and design of complete power reactor systems and components. Experience in power reactor systems and technology is preferred, including a knowledge of reactor safeguard methods.

Core Analysis. Complete nuclear analysis, including criticality determinations and flux distributions. Must also be conversant with fuel economics and fuel cycle optimization.

Shielding. Design and analysis of biological and thermal shielding for large power plants and compact mobile systems.

Heat Transfer and Fluid Flow. Steady state and transient experimentation and analysis. Power optimization studies; free and forced convection flow transients; boiling and two phase flow in water, organic and liquid metal systems.

Structures. Advanced analytical studies in thermal stress analysis, structural dynamics, elastic and inelastic behavior of plates and shells. Structural analyses are performed for transient and steady state operating conditions involving mechanical loads, thermal cycling and thermal shock.

Control. Includes analysis of complete plant control and the application of electronic analogue and digital computers to reactor systems. Experience in radiation monitoring and plant protection systems is necessary.

For specific details write: Mr. E. G. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

ATOMICS INTERNATIONAL

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Fuel and Materials Development

Senior Metallurgist, Physical Chemists and Engineers

Reactor Materials. Research involves investigation and analysis of mechanical and physical properties of metallic alloys and inter-metallic compounds. Materials are to be used in power reactors for fuel, and fuel cladding, moderators, control rods, and structural members. Studies will include analysis of materials after exposure to high temperatures and radiation fields.

Fuel Element Engineering. Responsible for the complete analysis and design of fuel elements. This includes nuclear, thermal, material, mechanical and cost analyses. Should be familiar with fuel life determination methods and reprocessing techniques.

Fuel Fabrication. Activities will include development fabrication of materials and fuel elements, for both plate and rod forms and complex assemblies. A knowledge of non-destructive testing methods is essential, in addition to familiarity with a wide range of material processing and fabrication techniques.

Irradiation Experimentation and Hot Lab Evaluation. Senior Research Engineers and Physicists are required to design and conduct irradiation experiments on developmental materials including reactor fuels. The individuals must be familiar with a wide range of radiation and temperature conditions. Experimental conditions will include the simulation of conditions expected in full scale power reactors. Also senior personnel are needed to develop equipment and techniques required for the post-irradiation testing and evaluation of these experiments.

For specific details write: Mr. R. G. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

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FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

Industrial regulators
Tracer machine tools
Process control
Nucleonics
Aircraft engines
Flight path control
Fire control
Platform stabilization
Flight simulators
Computers
Test equipment
Magnetic Amplifiers
Potentiometers
Gears and dampers

The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and non-members from the Order Department

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Personnel Service, Inc.

(Continued from page 64A)

ENGINEERS. (a) Project Engineers, B.E.E. or B.S. in physics, advanced degree desirable; minimum of six years' experience in research, design and development of UHF and VHF systems. Wide-band background particularly desired. Supervisory ability, capable of preparing estimates for new projects, etc. Salary, $15,000 a year. (b) Senior Engineers, B.E.E. or B.S. in physics, advanced degree desirable. Minimum of four years' experience in research and development of UHF and VHF systems. Wide-band background particularly desirable. Salary, $10,400 a year. (c) Engineers, B.E.E. or B.S. in physics or equivalent, with one to four years' experience as design engineer, preferably with UHF, IF or heavy pulse. Work involves the application of advanced circuit design techniques. Salary, to $9360 a year. Company will pay placement fees. Location, Long Island, N.Y. W7454.

ELECTRICAL ENGINEER, graduate, with at least three years' experience, to maintain responsibility for engineering policy for the electrical distribution system, substations, transformer banks and internal wiring of buildings, including lighting and power wiring. Duties will include desgn and development of lighting and power layouts for building construction and modification. Salary, $8810 a year. Location, Maryland. W7461.

SALES TRAINER, electrical or mechanical graduate, with three to five years' field sales and application engineering covering relays and signaling systems, to train manufacturers' agents covering estimates, specifications, etc. Considerable traveling throughout U.S. Salary, $8000 a year. Headquarters, New Jersey. W7467.

APPLICATION ENGINEERS. (a) Senior Application Engineer, with experience in sales or use of industrial instruments and controls. i.e. temperature measurements using electronic potentiometers or application or selection of control systems, both electrical and pneumatic, for batch processes. Salary open. (b) Junior Application Engineer, with three to four years' experience in electro-mechanical drafting; broad knowledge DC-AC circuits and their uses in industrial work. Will prepare engineering drawings, purchase specifications and assemble general technical data. Salary open. Location, northern New Jersey. W7468.

ENGINEERS. (a) Engineering Writers, engineering degree, with several years' writing experience in the field of complex military systems. Will participate, on project level, in the preparation and writing of management progress and technical reports and specifications. Salary, to $12,500 a year. (b) Transmitter Engineers for development and design of radar transmitters, ranging from very low-power to super-power transmitters delivering peak power in the multi-megawatt range. Design effort ranges from low-power pulse and RF circuits to the design of super-power hard-tube pulsers and RF cavity-type amplifiers. Experience in the development and design of TV, radio, communications or radar transmitters required. Salary, to $17,000 a year. (c) Design Integration Engineers with eight to ten years' experience in the development and design of components for large complex military systems. Responsibilities will include circuit design consultation, electronic parts application and reliability and printed circuit design coordination. Salary, to $14,000 a year. Location, East. W7469.

ELECTRICAL ENGINEERS. (a) Electrical Engineer, with three to ten years' experience in design and manufacture of HF and VHF single side-band equipment. Salary, to $12,000 a year. (b) Electrical Engineer, with three to ten years' experience in radio transmitters, high power circuits, FM techniques, UHF circuitry and control circuits. Salary open. (c) Electrical Engineer, degree in electrical engineering or physics, with three to five years' experience in design and development of low power FM transmitters in VHF-UHF range. Design experience on FM modulation techniques, feed-back amplifiers and RF circuitry including mixers, cavity amplifiers and filters. Salary open. Company will negotiate placement fees. Location, New York Metropolitan area. W7474.

ENGINEERS. (a) Transformer Design Engineer, able to design electronic magnetic components as follows: Plant transformers; audio; chokes—both oil and dry up to 100 KVA. Salary, to $12,000 a year. (b) Field Engineer, three to five years' experience in TV broadcasting either as design or station engineer. Familiar with testing and all technical procedures in trouble shooting electronic equipment. Prior experience as field engineer and willing to travel 50% of time. Salary open. Company will negotiate placement fees. Location, New York Metropolitan area. W7475.

PLANT ELECTRICAL ENGINEER, professional engineer's license preferred, to be responsible for the coordination of the engineering phases of electric power generation and distribution. Plant engineering and consulting background experience including power plant operations and plant utilities; steam and water. Should be capable of making evaluations and preparing reports for top management. Starting salary, approximately $10,000 a year. Location, Michigan. W7478(a).

ELECTRICAL ENGINEER to work in quality control work. Must have background in magnetics or magnetic amplifiers or related components. Salary open. Company will pay placement fee. Location, Florida. W7496.

MARKETING MANAGER, Commercial Products, degree in business administration or engineering essential; graduate work desirable. Must have a minimum of five years' experience in the field of marketing and distribution of control systems or electro-mechanical components to industrial concerns, principally machine tool manufacturers. Experience should include supervisory and administrative positions. Familiarity with hydraulic components and with a wide variety of manufacturing industries most desirable. Will be responsible for organizing and administering a completely new marketing division. Must be capable of conducting market surveys, establishing pricing and O.E.M. discount policies and establishing a nationwide distribution and service system. Submit resume, indicate present salary. Company will negotiate placement fees and relocation expenses. Location, upstate New York. W7502.

ENGINEERS. (a) Development Engineer, Tantalum Electrolytic Capacitors, graduate chemical, physical chemical or electrical engineer. Experience directly in electrolytic types of capacitors. Duties will be to work in research and product level development in field of tantalum electrolytic capacitors. Salary, to $10,200 a year. (b) Relay Engineer, graduate electrical engineer with one to two years' industrial experience. Applicant will gradually assume increasing responsibility in field of all purpose relays. Salary, to $7800 a year. (c) Design and Laboratory Engineer, graduate engineer, to participate in design, development and environmental testing of semiconductor devices, capacitors, resistors, rheostats, relays, switches and variable transformers in modern research laboratory. Salary, to $9000 a year. Employer will pay placement fee. Location, Chicago area. C7389.

DEVELOPMENT ENGINEER, chemical, electrical engineer or physics. Three years' vacuum tube engineering experience in design, development or product engineering. Duties involve the design and development of special purpose electronic tubes. Must be able to make electron optic calculations pertaining to cathode ray tubes and to analyze electrical, mechanical or chemical problems dealing with special purpose vacuum and gas filled tubes. Salary, $8400-$10,200 a year. Employer will pay placement fee. Location, Illinois. C7443.

DESIGN, CONSTRUCTION AND MAINTENANCE ENGINEERS for steel plants. Graduate engineers with a minimum of five years' experience in one or more of the following: Blast Furnace and Coke Plant, Open Hearths; Rolling Mills; foundries; Wire Mills; Refractories and Fuels; Materials Handling; Structural and Foundations; Piping and Mechanical and Electrical. Work in Venezuela on two-year contract. Furnished apartments furnished for married men and family. Salaries range from $12,000-$15,000 a year plus bonus depending on experience. First two months of employment will be spent in company's office in New York at salaries ranging from $800-$1000 a month. C7445.

ELECTRICAL ENGINEER, five years' experience, field and construction experience desirable, also primary power distribution systems, control, lighting, interior power systems and specifications of equipment. Salary open. Employer will pay placement fee. Location, Chicago area. C7447(b).

ENGINEER. (a) Senior Development Engineer, Electro-Acoustic; advanced degree in electrical engineering or physics; five or more years' experience in electro-acoustic research and development; must know vacuum tube and transistor circuit design. Duties will be to conduct development work in electro-acoustic instrumentation and bioelectronics as related to hearing aids and diagnostic devices for determination of ear pathology. Will develop new products using advanced techniques in electronics, mechanics, acoustics, engineering physics, micro-miniaturization, transistor circuitry, transducers and audiometry. Will work with a small group of engineers for a manufacturer of hearing aids. Salary, $10,000-$13,000 a year. (b) Senior Electronics Engineer, three or more years' experience as above. Salary, $8500-$12,000 a year. Employer will pay placement fees. Location, Chicago. C7460.

PRODUCTION DEVELOPMENT ENGINEERS, B.S.E.E., five years' related experience, in power supplies for computers. Duties will be to head up project group in design and development of transformers, rectifiers, resistors, capacitors, etc. as related to power supplies, for a manufacturer of power supplies for computers. Salary, $8500-$10,000 a year. Employer will negotiate placement fee. Location, Ohio. C7463.

ELECTRICAL DESIGNER—POWER: E.E. preferred, with enough experience on commercial light and power plans and specifications, to layout work for assistant engineer and draftsmen on schools, hospitals, etc. For a consultant. $700. San Francisco. S(P)-4403.

DESIGN, DEVELOPMENT—REMOTE CONTROL SYSTEM: E.E. to M.S., 5 years' electrical control application engineering experience. Design and assist in development of complete complex electromechanical remote control system involving safe handling of isolated electric process switchgear, motor switches, contactors, relays and direct, recording, actuating, sensing control devices (electrical, electronics, mechanical); for temperature, motion limits, pressure, flow on medium to heavy equipment (close tolerance actuators and drives and structures). For nuclear development. Salary commensurate with experience—To $9,000 or more. Oregon. S(P)-4402-R.

DEVELOPMENT ENGINEERS — ELECTRONIC: E.E. (a), 3-6 years' in analog computor design and checkout to work on a simulated shipboard weapon system fire control using digital computers. (b) 2-5 years' electromechanical experience to design and develop electronic consoles. (c) 2 years' experience in transistor switching circuitry and pulse generation. Should know packaging and printed circuitry. Southern California. $530-810. S(P)-4399.

SYSTEMS ENGINEERS—SERVO: E.E. (a) Senior Systems Engineer: with 5 or more years' experience in servo system design with some computer design background. Will establish design parameters and translate same into engineer-component documentation and assist project engineer in set up and tests of trainer system. $725-925. (b) Systems Engineer: 2-3 years' experience in syncro and relay circuitry for weapons control systems design. $580-810. U.S. Citizen. For manufacturer. Southern California. S(P)-4398.

ASSISTANT PERSONNEL MANAGER—ENGINEERING DIVISION: Prefer Ph.D. in Applied Sciences, plus business administration training or experience, capable of handling responsible position for large well organized company. Will be responsible for technical recruitment, advanced scientific education, manpower development and utilization and forecasts. For a radar manufacturer. $10,000-15,000 plus benefits. Southern California. S(P)-4396.

APPRAISAL ENGINEERS — GOVERNMENT PROPERTY: Graduate from accredited school of engineering. To conduct valuation studies of utility or industrial properties for ad valorem tax purposes. Salary depends on experience. Apply by letter. Northwest. S(P)-4385.

DESIGNER — REFRIGERATION SYSTEMS: E.E., 3-4 years' experience, preferably on industrial electrical system controls. Must be able to draft as well as design layouts. $650 up. For a manufacturer. San Francisco Peninsula. S(P)-4380.

DESIGN ENGINEER—ELECTRICAL CONTROL SYSTEMS: E.E. with advanced control engineering, recent and solid experience at high level in all phases of complex control systems circuitry relating to use, application and operation of varied components, including standard and special automation, complex, interlocking systems; for machine tools, conveyor complexes, processing instrumentation, cranes, intricate missile tower operations; from remote adjacent or console centers; with special emphasis on unusual components (magnetic amplifiers, memory and computer elements, standard and unique instrumentation). $14,000 to $20,000. San Francisco Peninsula. S(P)-4367.

DESIGNER—DIGITAL DATA HANDLING SYSTEMS: E.E., minimum 5 years' in design of digital data handling systems, including work knowledge of millimicrosecond pulse and solid state circuit techniques. To design systems. $10-12,000, plus profit sharing bonuses. San Francisco East Bay. Employer will pay replacement fee. S(P)-4365.

ENGINEERING TEACHERS: (a) HEAD OF DEPARTMENT of Mechanics and Electricity. Prefer with PhD. in Mechanical Engineering (b) ASSOCIATE, B.S. or M.S. in Physics. Teach mechanics, strength of materials, thermodynamics, applied electricity. Salary open. Western State. S(P)-4343.

FIELD, SERVICE—COMPUTORS: E.E., about 2-3 years' engineering experience (analog experience particularly desirable); will service, install, adjust and instruct operating technicians on analog computors. For manufacturer. Considerable traveling. $600-900 per month, plus expenses. S(P)-4339(a). **SALES ENGINEER—ANALOG COMPUTORS:** E.E., must have had sales experience in electrical, electronic or equipment related to analog computors. 1 for San Francisco East Bay, 1 for Midwest or Eastern U.S. S(P)-4339(b).

DESIGNER—ANALOG COMPUTERS: E.E. Minimum 5 years design of analog computer systems or simulators. Should be informed about mechanical, mechanisms, transistorizing, electronics and electrical needs. Will participate in general program at project level for manufacturer. $10-12,000, plus profit sharng bonuses. Employer will pay placement fee. San Francisco East Bay. S(P)-4318.

STAFF AND OPERATIONAL — PUBLIC WORKS TYPE ACTIVITY: Electrical, Mechanical, Civil or related: Minimum 5 to 20 years' with extensive recent supervisor experience required. To conduct engineering administration, operational and craftsman supervision for all base services and maintenance functions and operational support (other than new construction on existing, complete, medium size, self-contained installation equivalent to a large remote industrial, municipal or military base, including permanent housing, offices, shops, schools, hospitals—streets, water, electrical, sewage, sanitary, docks, warehouses, stores, airfield and post. Resident Engineer to $20,000. Assistant to $14,000. Assisting (Industrial Relations, Engineering Design, Safety, Radiation) to $12,000. Superintendents (Electrical, Marine, Building Maintenance, Distillation, Communications, Mechanical Utilities, Power) to $16,000; Assistants, to $14,000. Assisting Engineers (Design, Draft), Safety Engineer, Senior Material Take-Off Engineer, Senior Material Coordinator, to $11,000. Senior Draftsman, Material Take-Off, Material Coordinator, to $10,000. Assistant Safety Engineer, Vehicle Dispatcher, Heavy Equipment Scheduler, Draftsman, to $9,000. Family quarters, U.S. Citizen only. Security Clearance required. 2 year contract with renewal privilege. Top pay. Income tax exemption. Supporting positions for working wives. Pacific Ocean Area. Apply by letter of application with complete details of work experience. S(P)-4355.

DESIGNER—LIGHT, POWER: E.E. or equivalent. 5-20 years' experience designing electrical circuits for architectural engineer consulting firm on commercial buildings (office, streets, public); would prefer some extending consultant's experience but not an absolute requirement. Must know California codes and be familiar with phases of general light powering, air conditioning and air refrigeration, electric circuits from main switches to devices, including conduit distribution boxes, wiring, etc. Will supervise electrical designer and 1 draftsman or head group with himself and 1 leadman and 4-5 draftsmen. Should maintain candid and pleasant relationship with co-workers. $4.25-5.00/hour plus occasional overtime and benefits and air conditioned office. For architect-engineer. Beverly Hills, California. S(P)-4351.

DESIGN DRAFTSMAN—LIGHT, POWER: E.E. background, good recent experience designing low voltage power and motor wiring for commercial, public and light industrial buildings for consulting engineer. Should have a practical construction background and knowledge of electrical work that goes with it; capable draftsman. 2-3 months' work, possibility of permanent employment. About $700. San Francisco. S(P)-4328.

PROJECT, DESIGN, DEVELOP—ELECTRICAL CIRCUITS: E.E. with heavy math, minimum 4 years' experience design, develop electrical circuits, also able to apply high level math in determining electrical parameters from displays on Cathode Ray tubes for electrical manufacturer. To $1050 month. San Francisco Peninsula. S(P)-4337-R.

SENIOR APPLICATION ENGINEER—ELECTRICAL EQUIPMENT: E.E., with 5 years' or more in electric power industry involving applications of large circuit breakers, switchgear, transformers, substations. Must be able to direct group in Sales Department preparing proposals and price estimates based upon engineering studies and analyses of customers needs and assist field representatives in getting orders. California. $8-10,000. S(P)-4331-R.

AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available **without cost**, so that all interested individuals may obtain them for study and comment, thereby supplying practical experience in their use before submission for adoption.

1A	General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (September 1941)
1D	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Electrical Insulating Materials (June 1957)
1E	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment (June 1957)
1F	Guide for Statistical Analysis of Test Data (June 1958)
52	Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)
58	Induction Motor Letter Symbols (January 1956)
59	Test Code for Metallic Rectifiers (March 1956)
64	Guide for Maintenance of Insulating Oil (November 1956)
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68	Device Numbers and Functions for Pipeline Pump Stations Under Automatic or Remote Control (February 1958) (Proposed supplement to C37.2)
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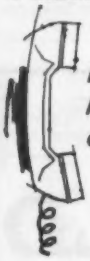

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Infrared systems and other modern-day electronic equipment use many special-purpose transformers having unusual electrical requirements. For example, the small cylindrical transformer shown connected to the decade box was designed by Radiation Electronics Corporation to operate at a primary signal level of 10^{-8} volts. Its primary and secondary impedances are 5 and 50,000 ohms respectively (dc resistance of primary only 0.6 ohm). Bandpass is from 12 cps to 45 kc. To measure these transformer characteristics, a test setup composed of the following G-R instruments is used:

1603-A Z-Y BRIDGE (at left) measures transformer impedances in terms of quadrature components at various frequencies and signal levels (transformer input voltage is varied by simply changing the bridge input). This Bridge can be balanced for *any* impedance from short circuit to open circuit, real or imaginary, positive or negative, over the entire audio-frequency range. Basic accuracy is 1%. Price: $370.

1217-A UNIT PULSER (upper center) provides a means for measuring low-frequency response to better than 0.3 cps — well below the range of conventional audio oscillators. Long-duration pulses are fed to the transformer under test, and low-frequency cutoff is determined by the measurement of the resulting pulse droop. Unit Pulser repetition rate 15c to 100 kc; pulse duration 0.2 μsec to 60,000 μsec. Price $235, Power Supply $40.

Photograph Courtesy
Radiation Electronics Corp., Skokie, Illinois

*This group of instruments is useful for the testing of electro-mechanical transducers and audio-frequency devices of all types.

1206-B UNIT AMPLIFIER (beneath Pulser) an ideal general-purpose amplifier — 3-watt output from 20c to 50 kc, 1.5 watts from 10c to 100 kc — less than 1% harmonic distortion. Price $85; Power Supply $40.

1432 DECADE RESISTANCE BOXES provide primary and secondary loads for the transformer under test. Decade Boxes are available in 10 different models in 0.1-Ω steps to 1000-Ω steps, total resistances from 111Ω to 1,111,100Ω. Prices range from $68 to $143.

546-C MICROVOLTER (extreme right) measures transformer gain and usefulness at very low signal levels. Used with an oscillator, the Microvolter supplies small, accurately-known voltages from 0.5 μv to 1.0v open circuit. Basic accuracy is 3%. Price: $140.

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